4.0 AIRFIELD CAPACITY & FACILITY REQUIREMENTS

A key step in the Airport Master Plan (AMP) process is determining future requirements for airport facilities that will allow for airside and landside development over the term of the 20-year planning period. By comparing the existing conditions of an airport to its predicted growth, an AMP process can define requirements for runways, taxiways, aprons, hangars, terminals, and other related airport facilities to accommodate growth over the short-, intermediate-, and long-term planning periods.

An essential step in the process of estimating future airport needs is the determination of an airport's current capability to accommodate anticipated demand. Such "demand-capacity" analyses aid in the identification of airport deficiencies, surpluses, and opportunities for future development. Ultimately, they yield information that is used to design the Airport Layout Plan (ALP) and set the stage for future facility development.

The Facility Requirements analysis establishes what airside and landside development should be planned for over the next 20 years.

This chapter of the Front Range Airport (the Airport or FTG) AMP identifies facility requirements for the Airport through the year 2037. Existing and future facility requirements and development standards are identified based on current Airport strategic development initiatives, and by comparing the Airport's existing facilities to future facility needs rooted in the forecasts of aviation demand presented in the previous chapter. The results of this **Airfield Capacity & Facility Requirements** chapter will serve as input into the next chapter, **Alternatives Analysis & Development Concepts**, that will present an examination of development alternatives to meet any current and projected deficiencies for the Airport. That analysis will ultimately result in identifying the best strategy to meet the needs of the Airport, its users, and the community.

Note that the Federal Aviation Administration (FAA) provides guidance for planning and design of airport facilities through Advisory Circulars (AC) that promote airport safety, economy, efficiency, and sustainability. Many of the facility requirements identified for FTG incorporate FAA planning and design standards presented in FAA AC 150/5300-13A, *Airport Design*, and FAA AC 150/5060-5, *Airport Capacity and Delay.* Other FAA ACs were used to develop sections of this chapter and are cited throughout the document.

4.1 Airfield Demand Capacity

"Airfield Demand Capacity" refers to the number of aircraft operations that a given facility can accommodate on either an hourly or yearly basis. (Note that capacity does not relate to the size or weight of aircraft.) The capacity of an airfield is primarily a function of the major aircraft operating infrastructure elements that comprise an airfield (i.e., runways and taxiways), as well as their alignment and configuration. It is also related to and considered in conjunction with wind coverage, airspace utilization, and the availability and type of navigational aids. Each of these components has been examined as part of the airfield demand capacity analysis.

Delays that result from a deficiency in airfield capacity produce real losses with respect to time, money, and productivity.

Airfield capacity is generally defined as the number of aircraft operations that can be safely accommodated on the runway-taxiway system at a given point in time before an unacceptable level of delay is experienced. The ability of Front Range Airport's current airside facilities to accommodate aviation operational demand is described below and is expressed in terms of potential excesses and deficiencies in capacity. The methodology used for the measurement of airfield capacity in this study is described in FAA AC 150/5060-5, *Airport Capacity and Delay*. This guidance is used in planning to determine the demand for an additional runway. Key terms relative to the discussion of capacity are:

- Demand – the magnitude of aircraft operations to be accommodated in a specified period of time, provided by the forecasts.
- Capacity – a measure of the maximum number of aircraft operations that can be accommodated on an airport in one hour.
- Annual Service Volume (ASV) – a reasonable estimate of an airport's annual capacity (i.e., level of annual aircraft operations that will result in an average annual aircraft delay of approximately one to four minutes).
- Delay – the difference between the actual time it takes an aircraft to operate on the airfield and the time it would take the aircraft if it were operating without interference from other aircraft or other influences, usually expressed in minutes.

Airfield capacity is defined as the theoretical number of aircraft operations that an airport can accommodate within a given period of time.

There are several factors known to influence airport capacity. Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) hourly capacities are based on the following assumptions:

- Runway-use Configuration. The appropriate runway use configuration (No. 14) was taken from Figure 2-1 in the Advisory Circular.
- Percent Arrivals. Arrivals equal departures.
- Percent of Touch and Go's. Approximately 55%-65% of the total operations are typically considered to be "touch and go" local operations. Based on data from the FTG Air Traffic Control Tower (ATCT), 65% of all operations are currently touch and go's, although that percentage is expected to decrease to 60% over time.
- Taxiways. The Airport has dedicated full-length parallel taxiways serving both the primary runway and crosswind runway. They each provide ample runway entrance/exit taxiways.

- Airspace limitations. Even with its close proximity to Denver International Airport (DEN), FTG has very few airspace procedural conflicts, all of which are addressed by the Airport's dedicated ATCT.
- Runway Instrumentation. The Airport has three published precision approach procedures that allow access during inclement weather conditions.
- Mix Index. This index is a mathematical expression used to represent the percentage of operations conducted by various classes of aircraft using the Airport. While FTG regularly serves mid to large corporate aircraft, the majority of operations are projected to remain with smaller aircraft. Therefore, the Mix Index is estimated to fall between 0%-20% (the weighed share of larger aircraft) based on existing fleet usage and will continue to be in this range in future years. This index range is used as a reference for determining the ASV.

Considering these factors under optimum conditions, FTG would have a VFR hourly capacity of 150 operations, and an IFR capacity of 59 operations. Based on annual forecast figures presented in **Chapter 3**, the Airport will likely not experience peak hour activity near this level throughout the forecast period.

Further, by applying methodologies found in the Advisory Circular on capacity and demand, the ASV for FTG has been calculated to be a maximum of 270,000 annual operations. (It should also be noted that the capacity of the Airport is enhanced by the presence of the ATCT.)

The forecast for annual operations is expected to increase from 81,905 (2017) to 114,823 operations by the end of the forecast period (2037). **Table 4-1** compares FTG's expected forecasted demand to its estimated capacity.

TABLE 4-1 - AVIATION DEMAND CAPACITY ANALYSIS

	2017	2022	2027	2037
Capacity - ASV	270,000	270,000	270,000	270,000
Demand - Aircraft Operations	81,905	86,045*	94,712*	114,823*
Percent of Capacity	30.3%	31.9%	35.1%	42.5%

*Forecasted, per Chapter 3.

According to the FAA, the following guidelines should be used to determine when airport capacity improvements should be enacted as demand reaches designated airfield capacity levels.

- 60% of ASV: Threshold at which planning for capacity improvements should begin.
- 80% of ASV: Threshold at which planning for improvements should be complete and construction should begin.
- 100% of ASV: The airport has reached the total number of annual operations (demand) it can accommodate, and capacity-enhancing improvements should be made to avoid extensive delays.

According to FAA's standards, FTG should start planning for capacity improvements when airport operational levels reach 162,000 operations (60% of ASV), and should initiate construction of those improvements at 216,000 operations (80% of ASV).

Based on the range of forecasts presented in **Chapter 3 - Forecast**, it is not anticipated that FTG will exceed any of the hourly or annual capacities in any given year during the 20-year planning period.

Conclusion: Since the operations forecasted in the 20-year planning period will not exceed 60% of the ASV, planning for additional airfield capacity will not be required during this planning period.

4.2 Airfield Facility Requirements

Airfield facilities generally include those that support the transition of aircraft from flight to the ground or the movement of aircraft from parking or storage areas to departure and flight. This section describes the airside requirements needed to accommodate the current and projected general aviation activity at Front Range Airport throughout the planning period.

Areas of particular focus include FAA airport design classifications and dimensional standards, runway and taxiway design standards and requirements, airfield pavement, visual and navigational aids, and obstructions and airspace requirements.

4.2.1 Airport Design Requirements

The FAA defines a wide variety of airport dimensional design requirements in order to promote safety, efficiency and consistency at airports across the country. In that these standards can change over time due to updates to the regulatory documents, changes to local airport operational patterns, or due to some other priority, it is important that a Master Plan review all of the critical design criteria to ensure compliance or to identify areas of improvement. This section reviews those standards contained in FAA AC 150/5300-13A, which presents the FAA design criteria for FTG based on its current and projected operational patterns throughout the planning period.

Improvements recommended in this section to maintain safety clearances on the airfield will be shown on the ALP prepared for this Airport Master Plan.

Design Aircraft Classification

The basis for the FAA airport design standards is the “design” or “critical design aircraft,” defined as the largest aircraft or family of aircraft anticipated to utilize a given airport on a regular basis. The FAA defines “regular basis” as conducting at least 500 annual itinerant operations (defined as a takeoff or a landing). As described in **Chapter 3**, the existing and future design aircraft for FTG was identified as a mid- to large-sized corporate jet, such as a Bombardier Challenger CL 604, a Challenger 300, a Cessna C750 Citation X, the Embraer ERJ145, and the Gulfstream G350.

Based on that selection of a design aircraft, an appropriate Airport Reference Code (ARC) can be identified. The ARC is a coding system used to relate airport design criteria to the operational and physical characteristics of the types of aircraft intended to operate at that airport. Specifically, the ARC is an airport designation that signifies the airport's highest Runway Design Code (RDC), which itself consists of the following components:

- The Aircraft Approach Category (AAC) (depicted by a letter and based on aircraft approach speed).
- The Airplane Design Group (ADG) (depicted by a Roman numeral and based on aircraft wing span and tail height).
- Runway Visual Range (RVR) (based on runway visibility minimums).

Table 4-2 shows the Aircraft Approach Categories, Airplane Design Groups and Visibility Minimums that comprise the Runway Design Code system, as well as representative aircraft.

TABLE 4-2 - RUNWAY DESIGN CODE SYSTEM (RDC)

Contributing Elements		
Aircraft Approach Category (AAC)		
Approach Category	Approach Speed	
A	< 91 knots	
B	91 knots ≤ 121 knots	
C	121 knots ≤ 141 knots	
D	141 knots ≤ 166 knots	
E	166 knots or more	
Airplane Design Group (ADG)		
Design Group	Wingspan	Tail Height
I	< 49 feet	< 20 feet
II	49 feet ≤ 79 feet	20 feet ≤ 30 feet
III	79 feet ≤ 118 feet	30 feet ≤ 45 feet
IV	118 feet ≤ 171 feet	45 feet ≤ 60 feet
V	171 feet ≤ 214 feet	60 feet ≤ 66 feet
VI	214 feet ≤ 262 feet	66 feet ≤ 80 feet
Runway Visual Range (RVR) - Visibility Minimums		
RVR (ft)	Instrument Flight Visibility Category (statute mile)	
5000	Not lower than 1 mile	
4000	Lower than 1 mile but not lower than ¾ mile	
2400	Lower than ¾ mile but not lower than ½ mile	
1600	Lower than ½ mile but not lower than ¼ mile	
1200	Lower than 1/4 mile	

Source: Jviation, FAA AC 150/5300-13A.

Both of FTG's existing runways meet FAA's design criteria for RDC of C-II-2400 based on existing conditions and aircraft operations. Additionally, as detailed in **Chapter Three**, the future critical design aircraft is projected to be consistent with current operational patterns; hence, the RDC will remain as a C-II. Specifically, this designation represents a wide variety of mid-sized to larger business aircraft (see

Figure 4-1). Given that the RDC for both of the Airport's runways will remain a C-II, the ARC for FTG will also remain a C-II.

FIGURE 4-1 - RDC C-II AIRCRAFT

Source: Jviation

Like runway design, taxiway design standards are based on a combination of the ADG and the Taxiway Design Group (TDG) criteria, also defined in FAA AC 150/5300-13A. The TDG is centered on the ratio of the overall Main Gear Width (MGW) to the Cockpit to Main Gear (CMG) distance of the critical or design aircraft. As described in previous sections, the current design aircraft for FTG is the Bombardier Challenger CL 604, which translates to a TDG 2 classification. See **Table 4-3** for a summary of all existing, future and ultimate Airport Design Standard classifications for FTG.

TABLE 4-3 - FTG DESIGN STANDARD CLASSIFICATIONS

	Existing	Future	Ultimate*
Aircraft Approach Category (AAC)	C	C	C
Airplane Design Group (ADG)	II	II	IV
Runway Visual Range (RVR)	2400	2400	2400
Runway Design Code (RDC)	C-II 2400	C-II 2400	C-IV 2400
Airport Reference Code (ARC)	C-II	C-II	C-IV
Taxiway Design Code (TDC)	2	2	3

Source: FAA AC 150/5300-13A.
*The "ultimate" classifications are recommended for long-term considerations. These are not endorsed by the FAA which cannot issue approvals beyond the "future" planning range.

It should be noted that the future ARC and RDC recommendations provided above are consistent with the existing ALP and will not substantively change any proposed safety or design related projects shown on the current ALP. The ultimate ARC, RDC and TDG have been established to preserve for potential development that could occur beyond the 20-year planning period and reflect accommodating the largest existing aircraft currently being utilized for general aviation.

FAA Airport Design Standards

FAA airport design standards include requirements for physical runway and taxiway characteristics as well as safety-related areas and setbacks. As described in FAA AC 150/5300-13A, *Airport Design*, these standards are established for individual airport facilities (e.g., runways, taxiways, etc.) based on several variables that can include

RDCs, TDGs, instrument approach minimums, etc. FAA require airports to meet these standards to help ensure safe and efficient operations.

It should be noted that any condition on an airport that does not meet FAA design criteria is considered to be "non-standard" and subject to correction. When local airport conditions are such that a non-standard condition cannot be corrected, it is at the discretion of the FAA to issue a Modification to Design Standards (MOD). On a case-by-case basis, the FAA may issue a MOD if it is necessary to accommodate unique local conditions for a specific project, while maintaining an acceptable level of safety. MODs are applicable to attaining equipment, design, or a construction project on an airport. Once the nonstandard condition is approved as a MOD, the standard at that location is no longer considered to be a non-standard condition. Note that there are currently no MODs in place at FTG.

Table 4-4 and **Table 4-5** provide summaries for FTG's compliance with these critical airport design standards with respect to its existing runways and its primary taxiways. Following the tables are brief overviews of the relevant airport design standards as well as descriptions of any current deficiencies at FTG.

TABLE 4-4 - FAA RUNWAY DESIGN STANDARDS FOR FTG

Runway Design Standards	FAA Standard (RDC = C-II ≥ ½-Mile Vis)	Runway 08/26 (existing conditions)	Runway 17/35 (existing conditions)
Runway Width	100'	100'	100'
Runway Shoulder – Width – Surface	 10' Turf/Stabilized Soil	 10' 5' Asphalt + 5' Turf	 10' Turf
Runway Safety Area (RSA) – Width – Length	 500' 1,000'	 500' 1,000'	 500' 1,000'
Runway Object Free Area (ROFA) – Width – Length	 800' 1,000'	 800' 1,000'	 800' 1,000'
Runway Object Free Zone (ROFZ) – Width – Length beyond RW end	 400' 200'	 400' 200'	 400' 200'
Precision Object Free Zone (POFZ) – Width – Length	 200' 800'	 200' 800'	 200' 800'
Blast Pad* – Width – Length	 120' 150'	 0' 0'	 0' 0'
Runway Centerline to: – Parallel Taxiway Centerline – Aircraft Parking Area – Holding Position Markings	 400' 500' 250'	 400' >500' 275'	 500' >500' 305'

Source: Jviation, FAA AC 150/5300-13A, *Airport Design*

* FAA only requires blast pads for runways accommodating ADG IV and higher aircraft, and only recommends blast pads for runways accommodating ADG III aircraft

TABLE 4-5 - TAXIWAY DESIGN STANDARDS FOR FTG

Taxiway Design Standards	FAA Standard (TDG 2 / ADG II)	Taxiway A (existing conditions)	Taxiway D (existing conditions)
Taxiway Type	-	Full Length Parallel	Full Length Parallel
Associated Runway	-	RWY 08/26	RWY 17/35
Taxiway Width	35'	50'	50'
Taxiway Shoulder – Width – Surface	 20' Turf/Stabilized Soil	 20' Turf/Stabilized Soil	 20' Turf/Stabilized Soil
Taxiway Safety Area Width	79'	79'	79'
Taxiway Object Free Area Width	131'	131'	131'
Taxiway Centerline to: – Parallel Taxiway/Taxilane – Fixed or Movable object	 105' 65.5'	 197' 261'	 N/A 170'
Taxiway Wing Tip clearance	26'	26'	26'

Source: Jviation, FAA AC 150/5300-13A.

Runway Safety Area

The Runway Safety Area (RSA) is a defined surface surrounding the runway that is specifically prepared and suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the paved surface. RSAs are also required to be free of non-frangible objects except when fixed by function. As shown in **Table 4-4**, FTG's RSAs are currently compliant with FAA design standards.

FTG meets all RSA requirements for RDC C-II; no action is required.

Runway Object Free Area

The Runway Object Free Area (ROFA) is a two-dimensional FAA-defined runway safety standard that requires the clearing of objects within a specific area around a given runway. This standard requires the clearing of all above-ground objects protruding above the nearest point of the RSA. Exceptions to this requirement include objects that need to be located in the ROFA for air navigation or aircraft ground maneuvering purposes. In those cases, objects must meet FAA frangibility requirements. As shown in **Table 4-4**, FTG's ROFAs meet current design standards.

FTG meets all ROFA requirements for RDC C-II; no action is required.

Runway Obstacle Free Zone (ROFZ)

The Obstacle Free Zone (OFZ) is a volume of airspace intended to protect aircraft in the early and final stages of flight. It must remain clear of object penetrations, except for frangible Navigational Aids (NAVAIDs) located in the OFZ because of their function. For runways serving aircraft with Maximum Takeoff Weight (MTOWs) greater than 12,500 pounds, the OFZ is 400 feet wide and extends 200 feet beyond the end of the runway. As shown in **Table 4-4**, FTG's ROFZs meet current design standards.

FTG meets all ROFZ requirements for RDC C-II; no action is required.

Precision Obstacle Free Zone

The Precision Obstacle Free Zone (POFZ) is defined as a volume of airspace above an area beginning at the threshold at the threshold elevation and centered on the extended runway centerline that is 200 long by 800 feet wide. It exists on runway ends that have a vertically guided approach, and is only in effect when the reported ceiling is below 250 feet or visibility is less than ¾ statute mile, and an aircraft is on final approach within two miles of the runway threshold. Only a wing of an aircraft holding on a taxiway waiting for runway clearance may penetrate the POFZ as can airport vehicles up to 10 feet in height that are necessary for maintenance. FTG has POFZs on the approach ends to Runway 26 and Runway 35; all currently meet those POFZ requirements.

FTG meets all POFZ requirements for RDC C-II; no action is required.

Runway Protection Zone

A Runway Protection Zone (RPZ) is an area beyond each runway end designed to enhance the protection of people and property on the ground. To ensure that the RPZs are kept clear of incompatible uses, the land included in the RPZ should be owned by the Airport or protected via an avigation easement. This gives the Airport the right to control the presence and height of objects as well as the use of the land within the RPZ. The FAA Memorandum, *Interim Guidance on Land Uses Within a Runway Protection Zone*, indicates that existing incompatible land uses within the RPZ should be removed when those land uses would enter the limits of the RPZ as the result of:

- An airfield project (e.g., runway extension, runway shift)
- A change in the critical design aircraft that increases the RPZ dimensions
- A new or revised instrument approach procedure that increases the RPZ dimensions
- A local development proposal in the RPZ (either new or reconfigured)

The size of an RPZ for a particular runway end is a function of the critical aircraft and the visibility minimums established for that end. Visual runways have smaller RPZs because the landing minimums are higher and the runway is not used during periods of reduced visibility. Essentially, the greater precision of the approach (and the lower the visibility minimums for landing), the larger the resulting RPZ. **Table 4-6** presents FTG's RPZ design criteria. All the Airport's RPZs currently meet FAA design standards.

TABLE 4-6 - RUNWAY PROTECTION ZONE DIMENSIONS

RPZ Criteria	RWY 08	RWY 26	RWY 17	RWY 35
Visibility Minimums	Visual	½-mile	¾-mile	½-mile
Approach RPZ				
– Length	1,700 ft	2,500 ft	1,700 ft	2,500 ft
– Inner Width	500 ft	1,000 ft	1,000 ft	1,000 ft
– Outer Width	1,010 ft	1,750 ft	1,510 ft	1,750 ft

Source: Jviation, FAA AC 150/5300-13A

FTG meets all RPZ requirements; no action is required.

Building Restriction Line (BRL)

A Building Restriction Line (BRL) is the line indicating the limit of where airport buildings can be located in order to limit their proximity to aircraft movement areas. The BRL is an amalgamation of airport design standards including RPZs, OFAs, OFZs, the runway visibility zone, NAVAID critical areas, and various other critical airspace-related areas (typically associated with a 35-foot building height limitation). The BRL at FTG considers all of these factors. Note that structures taller than 35 feet require additional analysis to ensure compliance with the 14 CFR Part 77 surfaces.

FTG meets all BRL requirements, all existing buildings are located outside of the BRL; no action is required.

Runway Line-of-Sight Requirements

For a single runway or a system of non-intersecting runways, the runway line-of-sight standard requires that two points located five feet above the runway centerline must be mutually visible for the entire runway length. However, if there is a full-length parallel taxiway (like Taxiway A and Taxiway D at FTG), that visibility requirement is reduced to one half of the runway length.

FTG meets all Line-of-Sight standards; no action is required.

Runway Blast Pads

A runway blast pad is a paved surface adjacent to the ends of runways designed to reduce the erosive effect of jet blast and propeller wash during takeoff operations. FTG currently lacks blast pads on all its runway ends. FAA requires blast pads for runways accommodating ADG IV and higher aircraft, and recommends blast pads for runways accommodating ADG III aircraft. Since FTG's ADG is planned to be II throughout the planning period, no action is required. However, if either runway's ADG were to ultimately be increased to III or above, blast pads would have to be constructed.

FTG meets blast pad design standards; no action is required.

Runway & Taxiway Shoulders

Shoulders are areas adjacent to the defined edge of paved runways or taxiways that provide a transition between the pavement and the adjacent surface. They are designed to enhance drainage, provide for blast protections, and support aircraft and emergency vehicles that deviate from the full-strength pavement. Like runway blast pads, FAA requires paved shoulders for runways and taxiways accommodating ADG IV and higher aircraft, and recommends paved shoulders for runways and taxiways accommodating ADG-III aircraft. Based on its current ADG C-II classification, the Airport meets the current shoulder standards for all its runways and taxiways.

FTG meets all runway and taxiway shoulder design standards; no action is required.

Taxiway Design Standards

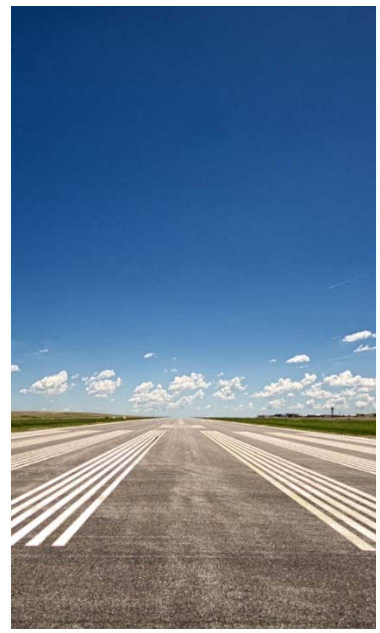
Similar runway design requirements, all taxiways have FAA-mandated Taxiway Safety Area (TSA) and Taxiway Object Free Area (TOFA) design requirements to help ensure safe operational conditions on an airport. These standards promote the safe movement of aircraft without the threat of aircraft wingspan striking any objects or other aircraft. As shown in **Table 4-5**, FTG's taxiways meet current design standards.

FTG meets all taxiway design standards; no action is required.

4.2.2 Runways

Runway Orientation

The runway configuration is the physical layout of the airfield system, including the number of runways, their orientation, and their locations relative to each other, as well as to the landside facilities. Each runway configuration has a different capacity due to operational limitations and restrictions. For example, runways that converge or intersect have lower capacities than parallel runways since an aircraft on a converging runway must wait to land or takeoff until the aircraft on the second converging runway has either completed its landing or has cleared the path for aircraft arriving or departing from the other runway.



Runway 8 at FTG

As described in *Chapter Two*, FTG has two runways: Runway 08/26 is positioned in an East/West orientation, while Runway 17/35 is positioned in a North/South alignment. These runways effectively converge on each other since they do not allow for independent simultaneous operations (meaning that only one runway can be operational as a time, even during ATCT operations). However, even though the Airport's runways and approach paths converge, reducing their overall operational potential, the overall capacity of the airfield remains substantially above the demand projected over for the planning period.

Additionally, climatological conditions specific to the location of an airport not only influence the layout of the airfield, but also affect the use of the runway system. Surface wind conditions have a direct impact on airport operations in that runways not oriented to take the maximum advantage of prevailing winds will restrict the capacity of an airport to varying degrees. When landing and taking off, aircraft are able to operate properly on a runway if the wind component perpendicular to the direction of travel (defined as a crosswind) is not excessive (generally, this is specific to the operational requirements and capabilities of individual aircraft).

Surface wind conditions (i.e., direction and speed) generally determine the desired alignment and configuration of the runway system. Wind conditions affect all airplanes in varying degrees; however, the ability to land and takeoff in crosswind conditions varies according to pilot proficiency and aircraft type. It can be generally stated that the smaller the aircraft, the more susceptible it is to the effects of crosswinds. To determine wind velocity and direction at Front Range Airport, wind data from observations taken at the Airport from 2005 to 2015 was obtained from the National Climatic Data Center and was utilized to construct new VFR, IFR and all-weather wind roses.

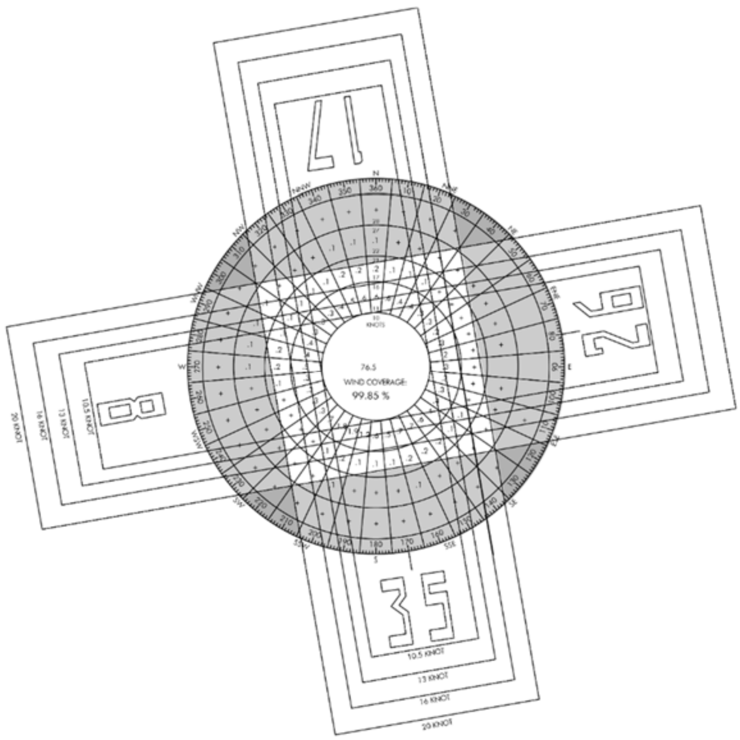
The allowable crosswind component is dependent upon the types of aircraft that utilize the Airport on a regular basis. As described earlier, the future RDC for both FTG runways is C-II. Based on FAA AC 150/5300-13A, this RDC requires that a 16-knot crosswind component be utilized for this analysis. The crosswind components of 10.5, 13, and 16 knots were used for this analysis to look at the allowable crosswind component for various sizes of aircraft. The following illustrations (**Figure 4-2** and **Figure 4-3**) illustrate the all-weather wind coverage wind rose generated for the Front Range Airport. According to the FAA, the desirable wind coverage for an airport is 95% during all weather conditions. This means that the runway orientation and configuration should be developed so that the maximum crosswind component is not exceeded more than 5% of the time annually. (Note that this is a recommendation, not a requirement.) As shown in **Table 4-7**, FTG's crosswind coverage in all weather conditions is 98.52% (at 10.5 knots), exceeding FAA's minimum recommended coverage of 95%. Therefore, the wind coverage at FTG by its current runway orientation is considered to be adequate for the planning period.

TABLE 4-7 - FTG WIND COVERAGE

	10.5 knots	13 knots	16 knots
All Weather			
Runway 8/26	85.52%	91.42%	97.08%
Runway 17/35	92.76%	95.91%	98.47%
Combined	98.52%	99.54%	99.87%
IFR			
Runway 8/26	79.16%	86.49%	93.97%
Runway 17/35	93.37%	96.86%	99.29%
Combined	98.59%	99.64%	99.86%
VFR			
Runway 8/26	85.86%	91.69%	97.24%
Runway 17/35	92.73%	95.87%	98.44%
Combined	98.50%	99.52%	99.87%

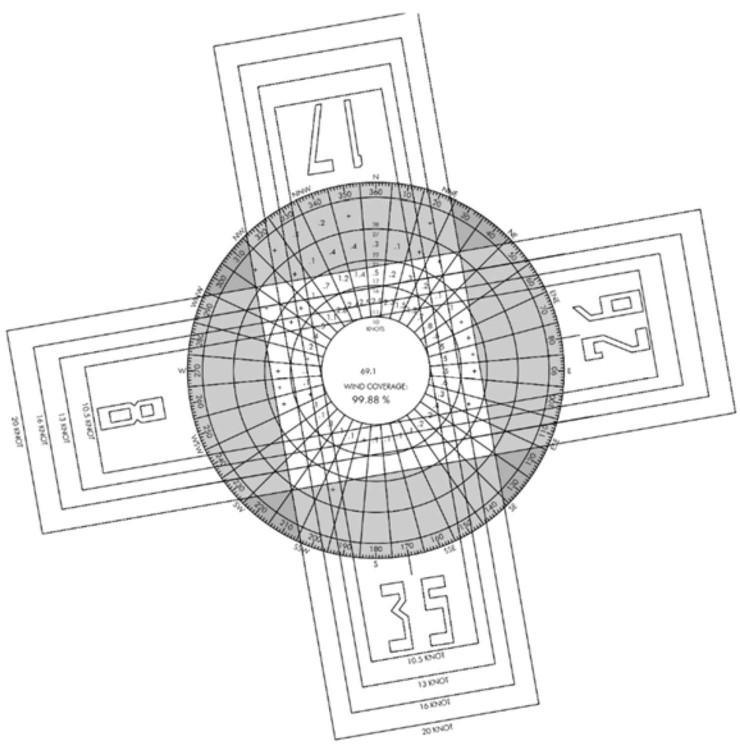
Source: NCDC, Station 724694, FAA AGIS Wind Rose Form, FTG Annual Period of Record: 2005-2015

FIGURE 4-2 - ALL-WEATHER WIND ROSE



Source: FAA Wind Rose Analysis, Jviation

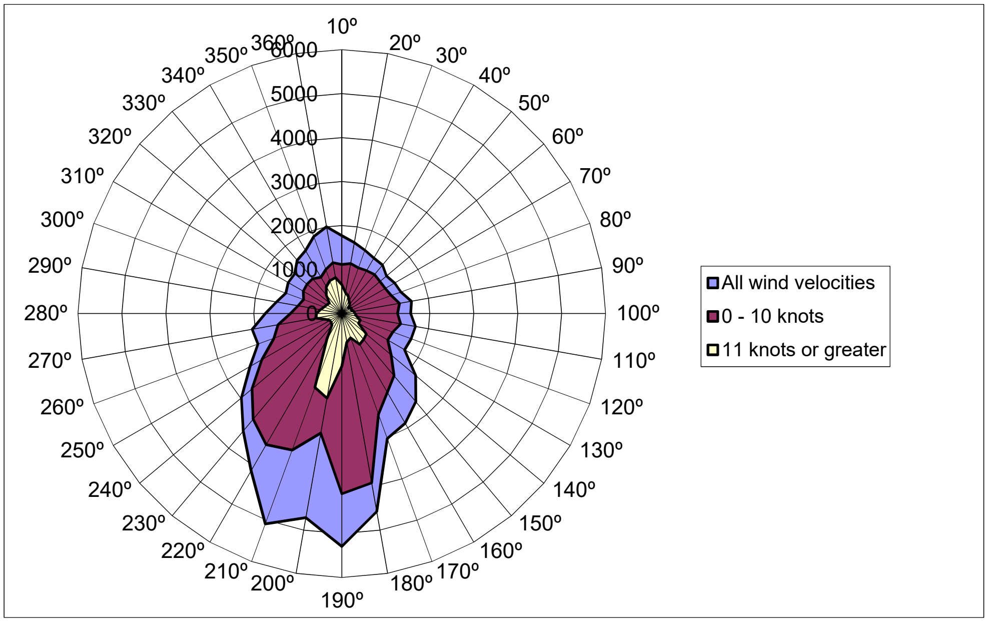
FIGURE 4-3 - IFR WIND ROSE



Source: FAA Wind Rose Analysis, Jviation

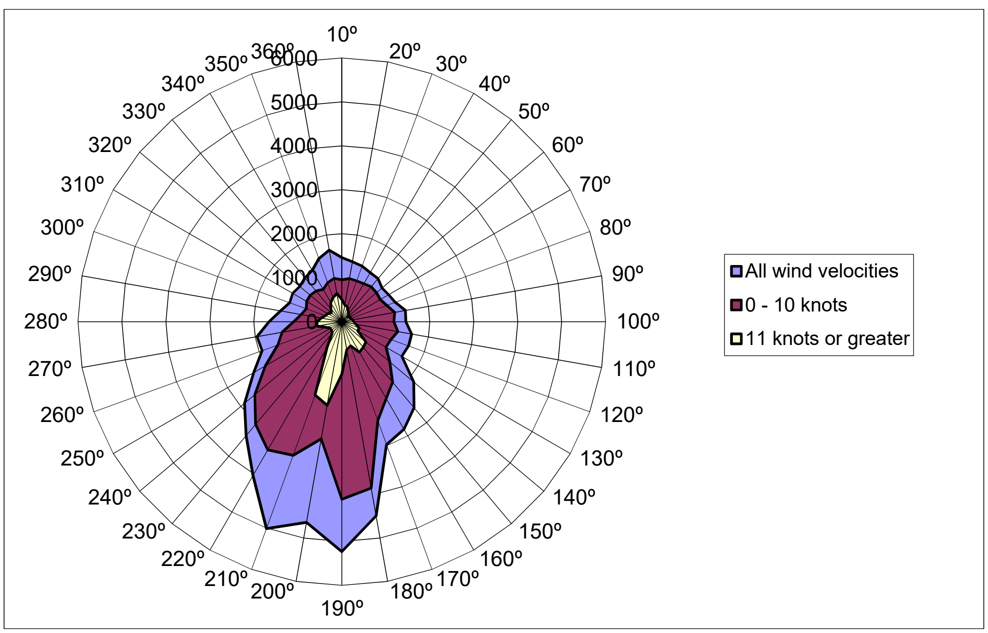
Beyond these wind rose percentage calculations, it is often useful to examine annual wind persistency trends near the Airport to identify any potential anomalies that should be considered. **Figure 4-4**, **Figure 4-5**, and **Figure 4-6** reflect annualized wind patterns at FTG based on all weather, VFR, and IFR weather conditions, respectively.

FIGURE 4-4 - ALL-WEATHER WIND PERSISTENCY



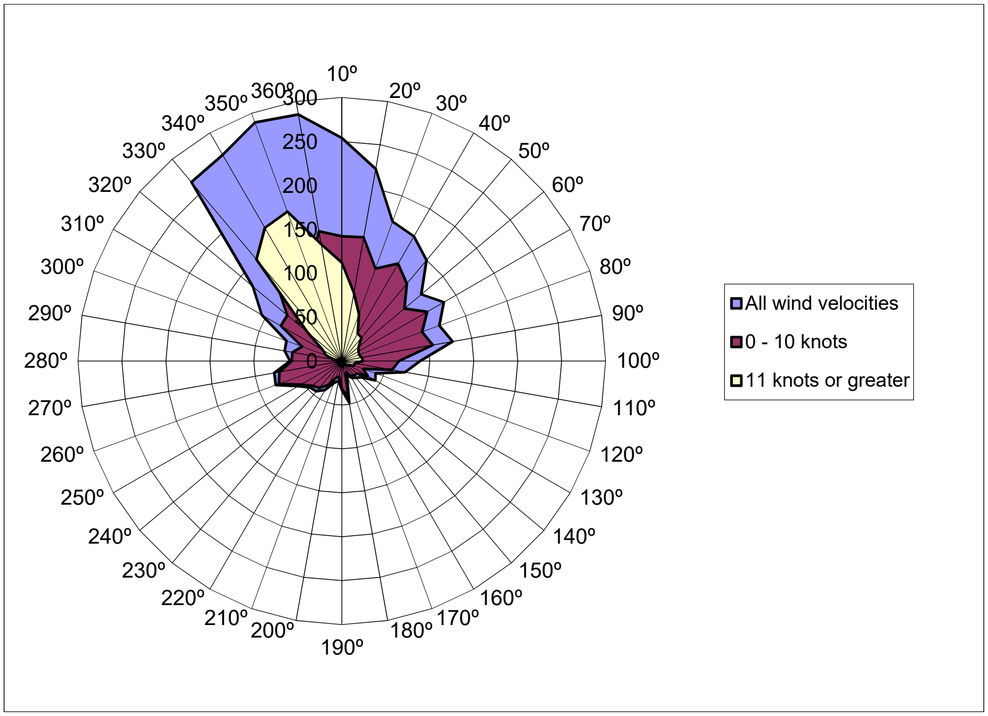
Source: Jviation, FAA GIS wind rose generator; station 724694 2005-2014 annualized data

FIGURE 4-5 - VFR WIND PERSISTENCY



Source: Jviation, FAA GIS wind rose generator; station 724694 2005-2014 annualized data

FIGURE 4-6 - IFR WIND PERSISTENCY



Source: Jviation, FAA GIS wind rose generator; station 724694 2005-2014 annualized data.

Demonstrated in the wind coverage analysis, and reinforced by the persistency tables shown above, winds are typically blowing in the northerly or southerly direction, calling for greater usage of Runway 17/35. The current runway configuration at FTG adequately accommodates the requirements of the area weather patterns.

The existing configuration for FTG's runway layout provide adequate wind coverage and capacity per FAA guidance, no further alternatives will be recommended during the 20-year planning period.

Runway Length

The purpose of this section is to determine if the lengths of the existing runways are adequate to accommodate the aircraft fleet currently operating and projected to operate at FTG. It should be noted that in practical application, specific runway length requirements must be generated for each individual flight that originates at any airport. At FTG along with all other airports, these requirements are dependent on a wide range of variables (see **Figure 4-7**), many of which can vary dramatically daily or even hourly. For planning purposes, to normalize those variables, this runway length analysis was conducted in accordance with FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design,* to ensure that the existing and future runway lengths are suitable for the forecasted range of critical design aircraft. The FAA methodology establishes minimum runway length requirements based primarily upon several factors including airport elevation, average temperature, and type aircraft expected to use the runway on a regular basis.

FIGURE 4-7 - FACTORS AFFECTING RUNWAY LENGTH

Source: Jviation

Both runways at FTG are 8,000 feet long, and the Airport's published altitude is 5,512 feet Mean Sea Level (MSL) with a mean daily maximum temperature in the hottest month of 88.1° Fahrenheit. Additionally, as discussed previously, the future critical design aircraft is projected to maintain an RDC of C-II, which is representative of a wide variety of mid-sized to larger business aircraft (e.g., Cessna Citation X, Embraer ERJ145, Gulfstream G350, etc.). Through application of these criteria within the FAA methodology, runway length requirements were calculated and are presented below in **Table 4-8**.

TABLE 4-8 - RECOMMENDED RUNWAY LENGTHS FOR FTG

Category	Runway Data
Airport Elevation	5,512 feet
Mean Daily Maximum Temperature of the Hottest Month	88.1˚F
Maximum Difference in Runway Centerline Elevation	35.6 feet
Small Airplanes with Approach Speeds <30 Knots	465 feet
Small Airplanes with Approach Speeds <50 Knots	1240 feet
Small Airplanes with <10 Passenger Seats – 95% of these Small Airplanes – 100% of these Small Airplanes	 6,800 feet 7,000 feet
Large airplanes weighing less than or equal to 60,000 pounds:	
— 75% of these Large Airplanes at 60% Useful Load	6,800 feet
— 75% of these Large Airplanes at 90% Useful Load	8,600 feet*
— 100% of these Large Airplanes at 60% Useful Load	10,600 feet
— 100% of these Large Airplanes at 90% Useful Load	>11,000 feet
Airplanes of more than 60,000 pounds	See Manufacturer Data

Source: FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design*.
*Climb limitation is shown. Actual recommended runway length exceeds climb limitations.

Table 4-8 indicates that 75 percent of aircraft greater than 12,500 pounds and less than 60,000 pounds (a category which includes most corporate jets) can be accommodated by FTG's existing 8,000-foot runways with limited to no operational penalties. The Airport currently has sufficient runway length to accommodate all of the small aircraft with less than 10 passenger seats. For aircraft weighing more than 60,000 pounds, runway length requirements are more appropriately calculated through specific aircraft manufacturer technical data. It should be noted that depending upon the stage length, aircraft can operate on shorter runways by modifying the aircraft loading (i.e. passengers, fuel, or cargo). Reduction of useful load and payload by the business jet fleet is typical when operating on runways of less than optimal length.

To date, neither current users of FTG, nor the airport administration, have identified an immediate need for additional runway length. Documentation from users demonstrating the need for a longer runway length, or overriding needs for future aeronautical activities reasonably expected to occur would be necessary to justify a runway extension. Currently, no such demand or need for an exist, and therefore not warranted within the 20-year planning period.

However, it should also be acknowledged that the previous master plan, completed in 2004, proposed extensions for both runways at the Airport. A 2,000-foot extension for Runway 8-26 (for a total runway length of 10,000 feet) and a phased 4,000-foot extension for Runway 17-35 (for a total length of 12,000 feet) were recommended to accommodate future significant air cargo operations. Unfortunately, since the completion of that master plan, the economic and logistical conditions anticipated to occur that would support such cargo operations did not materialize. In fact, regional air cargo operations are now largely being accommodated at nearby Denver International Airport. However, as noted in the previous chapter, significant economic growth and development are steadily migrating eastward from Denver and towards Front Range Airport that would likely generate future demand for aeronautical activities at the Airport. This trend is likely to be enhanced by the Denver Intergovernmental Agreements and Revenue Sharing with Adams County that was approved in November 2015. It is expected that this agreement will result in an increasing rate of area development, which in turn, would realistically produce increased demand for general aviation activity. While the actual nature of this future demand is currently largely undefined, through discussions with airport management and the FAA, it was determined that it would be reasonable to preserve the potential for the runway extensions by continuing to show them on the Ultimate Airport Layout Plan sheet. This would enable the Airport and the FAA to continue to preserve the abutting land use and airspace for such enhancements in the future. Additionally, this action is supported by the 2011 Colorado Department of Transportation (CDOT) Aviation System Plan which identified FTG as not meeting its state system benchmark of 8,950 feet for runway length, indicating that the Airport should consider the potential for a longer runway in order for the state to meet its overall system goals.

The existing lengths for Runway 8/26 and Runway 15/35 are sufficient to accommodate most aircraft currently operating or projected to operate at FTG with minimal weight penalties; therefore, no runway extension is recommended within the 20-year planning period.

Runway Width

The required width of a runway is defined in FAA AC 150/5300-13A, *Airport Design*, and is a function of the RDC and the instrument approaches available for that runway. The minimum width for a C-II runway that is equipped with precision instrument approaches is 100 feet. Since both Runway 8-26 and Runway 17-35 are currently 100 feet wide, they are consistent with current airport design standards, and no changes are recommended in the planning period.

Additionally, as discussed in the previous section, the 2004 FTG Master Plan recommended not only extensions for both of Front Range Airport's runways, but also increases in their widths to 150 feet (to accommodate potential air cargo aircraft). Like the desire to protect for the long-term potential of the runway extensions, the Ultimate Airport Layout Plan will reflect the potential widening of both runways to protect for that potential development over the long term.

The existing width of Runway 8/26 and Runway 15/35 are sufficient to accommodate the current and projected design aircraft; therefore, runway widening is not recommended within the 20-year planning period.

4.2.3 Taxiways

Taxiway A9 at FTG

A taxiway system should be designed to facilitate safe and efficient aircraft movement to and from the runways and the aprons that serve passenger terminals, hangars, and general aviation facilities. It is generally recommended that an airport's primary runway be served by a full-length parallel taxiway to allow aircraft to enter or exit the runway environment as expeditiously as possible. At Front Range Airport, the taxiway system is based on two full-length parallel taxiways that each service one of its runways (Taxiway A, located south of Runway 8/26, and Taxiway D, located east of Runway 17/35). Taxiway A has seven access taxiways designed to allow aircraft to exit or enter Runway 8-26 at various distances, as does Taxiway D which has seven access taxiway connectors to Runway 17/35. Taxiway A also has four access taxiways linking it to the Terminal Area Apron, while Taxiway D has one access taxiway to the East Apron. Additionally, there are three taxiways (Taxiway B, Taxiway C, and Taxiway E) that connect the Airport's two runways and their associated support facilities. All taxiways are equipped with full signage and taxiway centerlines, but lack any lighting. It should also be noted that all taxiways (except for Taxiway C) are all in excellent condition with each having been rehabilitated or reconstructed within the past five years.

Taxiway Width

All taxiways at Front Range Airport have a current width of 50 feet. Based on the FAA design requirements as described in FAA AC 150/5300-13A, an airport with taxiways based on TDG 2 (like FTG) have a minimum width requirement of 35 feet. Therefore, the Airport's current taxiway widths meet the minimum requirements for width throughout the planning period.

The existing widths of the Airport taxiways will meet the FAA's minimum width requirements throughout the planning period. No action is required.

Taxiway Lighting

Taxiways at Front Range Airport do not currently have any type of taxiway lighting or reflectors. This is considered to be a potential safety issue by the FAA since clearly defining pavement boundaries, particularly during inclement weather, is an important goal in preventing potential deviations by vehicles from the taxiway environment. Therefore, the Airport should consider the installation of FAA-standard medium intensity taxiway lighting (MITL) systems for all of its taxiways.

The Airport should install MITLs on all of its taxiways to promote safe operations, particularly during inclement weather.

MITLs at FTG

Taxiway Capacity

As discussed above, Front Range Airport does not have a need to enhance its current overall airfield capacity through the addition of new taxiways within the 20-year planning period. However, there are two considerations that should be recognized. First, it was noted by representatives of the FTG Air Traffic Control Tower (ATCT) that FTG does experience occasional taxiway conflicts centered on Taxiway E. Specifically, during active periods of Runway 17/35 operations, aircraft flowing from the terminal area to the runway (and vice versa) must all utilize Taxiway E, which can only accommodate unidirectional travel. On the occasions when there are conflicting operations (i.e., an aircraft leaving the terminal area to depart on the runway, and another aircraft transitioning to the terminal area having landed on Runway 17/35), there can be a significant delay in that the ATCT would must either hold departing aircraft on Taxiway C or hold arriving aircraft on the East Apron. Additionally, during hours when the ATCT is closed, a situation could arise where two aircraft, heading in opposite directions, occupy Taxiway E at one time in conflict with one another. While it is understood that these conflicts are generally infrequent, they are likely to become more pronounced as activity at the Airport builds over time. Therefore, it is recommended that the Airport consider alternatives to eliminate these potential conflicts. Discussed in greater detail in the following chapter, the potential construction of an aircraft hold apron on the west side of Taxiway E large enough to allow an airplane to pull off the taxiway to allow for another aircraft to pass through would halve any delay time and provide a safe alternative for aircraft that find themselves facing opposite directions on Taxiway E. Alternatively, the potential construction of an end around taxiway (EAT) would accomplish similar results.

Second, as detailed in the 2004 FTG Airport Master Plan, there is a potential long-term need to construct a new, full-length parallel taxiway on the west side of Runway 17/35. Locating a taxiway on that side of the runway would significantly enhance the efficiency and safety of operations between the existing terminal area and Runway 17/35 by eliminating unnecessary crossings of the Runway 17 threshold to access the existing full-length parallel taxiway (Taxiway D). Additionally, this proposed configuration provides for an additional taxiway to alleviate the potential Taxiway E bottleneck described above. Therefore, the Airport should continue to show the existing taxiway system in its Future ALP, while also reflecting the enhanced system on its Ultimate ALP.

It is recommended that FTG resolve potential Taxiway E conflicts within the 20-year planning period. Additionally, the Airport should show an enhanced taxiway system on the Ultimate ALP to preserve for that potential development over the long term.

Other Taxiway Considerations

There are a variety of additional taxiway design requirements identified in FAA AC 150/5300-13A intended to enhance the overall safety of taxiway operations and minimize opportunities for runway incursions. Note that many of these requirements are relatively new (circa 2012) and were not in effect when most of FTG's pavements were constructed or during the previous master planning effort in 2004. These newer design principles for taxiway system layouts are listed in **Table 4-9**.

TABLE 4-9 - FAA TAXIWAY DESIGN PRINCIPLES

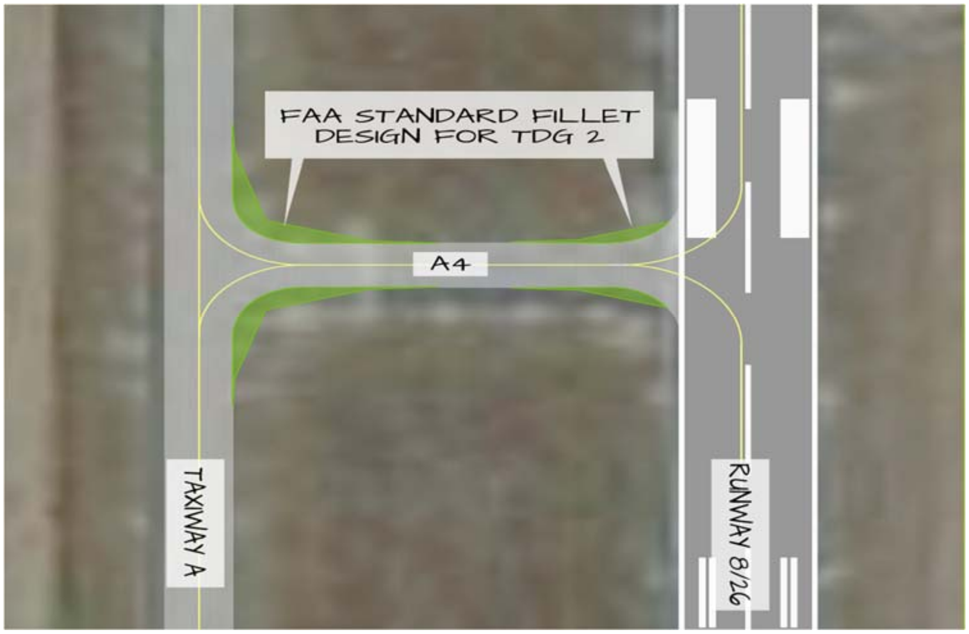
Design Principle	Summarized Definition
Steering Angle	– Design taxiways such that the nose gear steering angles is < 50 degrees
Fillet Design	– Traditional fillet design standards have been replaced – New fillet design more effectively reflects aircraft wheel tracks.
Standardize Intersection Angles	– 90 degree turns – 30, 45, 60, 90, 120, 135, and 150 degree preferred intersection standard angles
Concepts to Minimize Runway Incursions	
Increase Pilot Situational Awareness	– Utilize the “three-node concept” – Pilot should have three or fewer choices at an intersection (left, right, straight ahead)
Avoid Wide Expanses of Pavement	– Wide pavement requires placing signs far from a pilot’s eye
Limit Runway Crossings	– Reduces the opportunity for human error
Avoid “High Energy” Intersections	– Located in the middle third of the runways – Limit the runway crossings to the outer thirds of the runway
Increase Visibility	– Provide right angle intersections for best pilot visibility – Acute angle runway exits should not be used as runway entrance or runway crossing
Avoid “Dual Purpose” Pavements	– Runways used as taxiways and taxiways used as runways can lead to confusion
Indirect Access	– Eliminate taxiways leading directly from an apron to a runway
Hot Spots	– Limit the number of taxiways intersecting in one spot

Source: Jviation, FAA AC 150/5300-13A, *Airport Design*

Based on these newer taxiway design standards, the following recommendations are made for FTG's existing taxiway system:

- The updated taxiway fillet design should be incorporated into the future and ultimate ALP drawing set. The new fillet design should be instituted at the time of each taxiway's next major rehabilitation or reconstruction. (See example in **Figure 4-8**)
- Figure 4-8To prevent direct access from the Terminal Apron to Runway 8/26 via Taxiway A6 or Taxiway A7, the inner sections of those taxiways should be shifted. This would require a pilot leaving the apron area to make at least two intentional turns before accessing the runway, minimizing the potential for a runway incursion.
- To prevent direct access from the East Apron to Runway 17/35 via Taxiway D7, Taxiway D should be extended to the north to allow for a new access point to the apron. This would require a pilot leaving the apron area to make at least two intentional turns before accessing the runway, minimizing the potential for a runway incursion.

FIGURE 4-8 - TAXIWAY FILLET DESIGN STANDARDS



Source: Jviation

It is recommended that FTG eliminate the direct access from the Terminal Apron to Runway 8/26 by way of Taxiway A6, A7 as well as direct access from the East Apron to Runway 17/35 utilizing Taxiway D7. Additionally, it is recommended that the new taxiway fillet design standards be implemented on individual taxiways at the time of their next major rehabilitation or reconstruction.

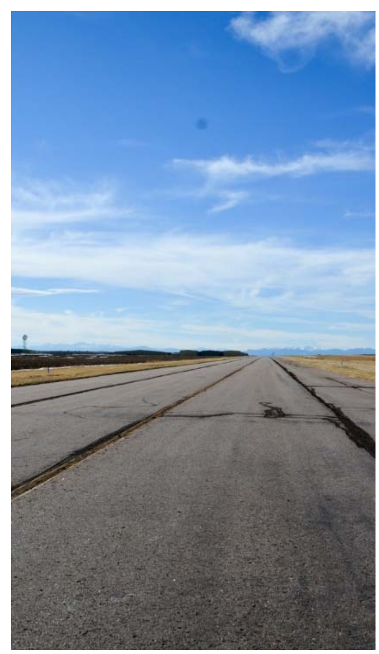
4.2.4 Airfield Pavement

Runway & Taxiway Pavement Strength

Airfields are constructed to provide adequate pavement strength for aircraft loads, as well as resisting the abrasive action of traffic and deterioration from adverse weather conditions and other influences. They are designed not only to withstand the loads of the heaviest aircraft expected to use the airport, but they must also be able to withstand the repetitive loadings of the entire range of aircraft expected to use the pavement over many years. Proper pavement strength design represents the most economical solution for long-term aviation needs.

There are several factors that must be considered when determining appropriate pavement strength for airfield structures. These factors include, but are not limited to, aircraft loads, frequency and concentration of operations, and the condition of subgrade soils. Runway pavement strength at airports is typically expressed by common aircraft landing gear configurations. Example aircraft for each type of gear configuration are as follows:

- Single-wheel: each landing gear unit has a single tire, example aircraft include light aircraft and some business jet aircraft.



Taxiway C at FTG

- Dual-wheel: each landing gear unit has two tires, example aircraft are the Boeing 737, Boeing 727, MD-80, CRJ 200, and the Dash 8.
- Dual-tandem: main landing gear unit has four tires arranged in the shape of a square, example aircraft are the Boeing 707 and KC135.

The aircraft gear type and configuration dictates how aircraft weight is distributed to the pavement and determines pavement response to loading. It should be noted that aircraft operating on a runway generally can exceed the defined pavement strength, but such operations will ultimately degrade the pavement prematurely and create wear issues that require more aggressive pavement maintenance. The published pavement strengths of the runways at FTG are presented in **Table 4-10**.

TABLE 4-10 - RUNWAY PAVEMENT STRENGTH

Runways	Published Pavement Strength	Surface & Condition	Representative Aircraft
Runway 8/26 – Single Wheel Gear (S) – Dual Wheel Gear (D)	 28,000 lbs 40,000 lbs	 Asphalt Good	 – Dassault Falcon 20 – Bombardier Challenger 604
Runway 17/35 – Single Wheel Gear (S) – Dual Wheel Gear (D)	 34,000 lbs 75,000 lbs	 Asphalt Good	 – Cessna Citation Excel – Gulfstream G-IV

Source: Jviation; FAA 5010 Data; FAA Airport Facility Directory.

The dual-wheel configuration is appropriate for application on both runways. At present, both runways' pavement is in good condition and their current strength is sufficient to accommodate the critical aircraft (Bombardier Challenger CL604). Therefore, no modification to pavement strength is currently required to meet the projected fleet mix. However, it should be noted that anecdotal evidence related to Runway 17/35 has indicated that its current pavement strength rating is understated. Specifically, it is believed that at the time of its last rehabilitation (2004), Runway 17/35 was in fact constructed to sustain a heavier aircraft than presently indicated. While there is not a need for greater pavement strength based on the current and projected demand levels presented in **Chapter 3**, this is a potential asset for the Airport that should be investigated further. On multiple occasions in the past, Front Range Airport has been approached regarding the potential of accommodating a limited number of larger general aviation aircraft (e.g., Bombardier Global Express, Gulfstream G650, Boeing Business Jet, etc.). (Note that the number of potential operations of large general aviation aircraft is very limited and would not impact the critical design aircraft determination for FTG.) These inquiries have been turned away since FTG could not meet the published pavement strength requirements for these aircraft. Given that in its role as a general aviation reliever airport FTG ideally would be able to accommodate the full range of general aviation aircraft (including large aircraft), and that the primary physical barrier to meeting the requirements of larger general aviation aircraft has historically been insufficient runway pavement strength, and that it is possible that barrier does not actually exist at Front Range Airport, it is recommended that the actual pavement strength of Runway 17/35 be determined.

Taxiway pavement strength is also expressed in terms of aircraft weights associated with common aircraft landing gear configurations. Based on the findings of the *Front Range Airport Pavement Evaluation Study* (2009) as well as the fact that all taxiway pavements on FTG (apart from Taxiway C) have been either reconstructed or rehabilitated since 2009, the taxiway pavement strengths at the Airport are considered to be sufficient to meet the needs of its existing and projected fleet mix. Additionally, it should also be acknowledged that if it were to be established that Runway 17/35 can accommodate heavier aircraft, in order to fully realize that capability for the Airport, strengthening of selected taxiway elements associated with the runway would likely be required. At a minimum, Taxiway D7, Taxiway D1, Taxiway D2, and that section of Taxiway D connecting D1 and D2 would all require an upgraded weight bearing capacity to avoid back-taxi operations on the runway.

The existing pavement strength of Runway 8/26, Runway 17/35 and the overall taxiway system is sufficient to accommodate the current and projected design aircraft; therefore, no pavement strengthening is required. However, it is recommended that the existing pavement strength for Runway 17/35 be determined.

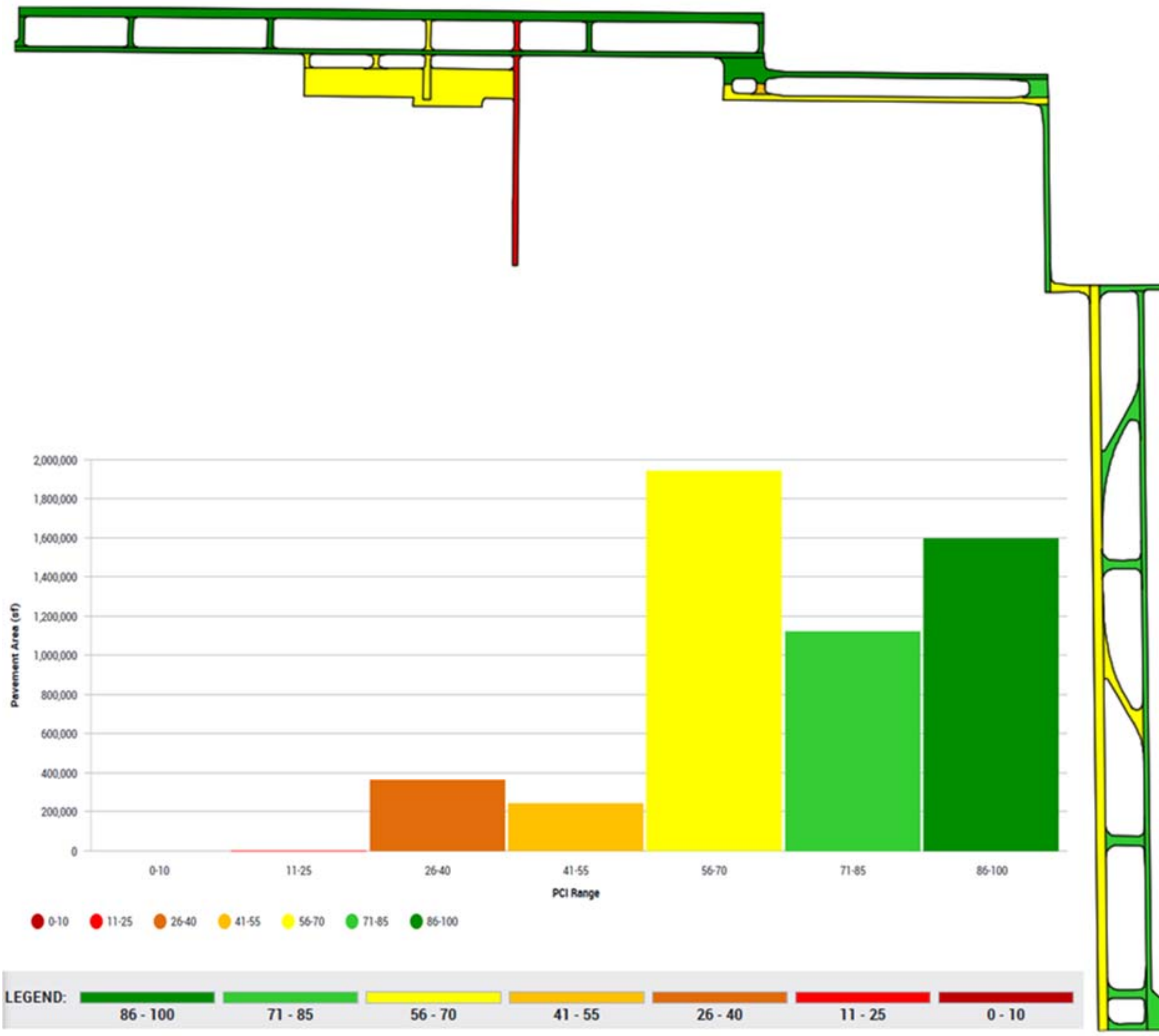
Runway & Taxiway Surface Condition

FAA AC 150/5380-6b, *Guidelines and Procedures for Maintenance of Airport Pavements*, recommends that detailed pavement inspections be conducted regularly to monitor conditions and establish an appropriate Pavement Condition Index (PCI) for each section. The 2014 CDOT Pavement Evaluation and Pavement Maintenance System Update, shown in **Routine maintenance*****, such as joint and crack sealing, should be performed on a scheduled basis to extend the pavement life. Taxiway C should be programmed for rehabilitation no sooner than 2019. Rehabilitation of other airfield pavements should be identified in appropriate timeframes within the 20-year planning period.***

Figure 4-9 identifies the majority of taxiway and apron pavement on the airfield to be in “Good” to “Excellent” condition, based on CDOT’s PCI ratings. This is consistent with expectations since both runways and nearly all taxiways have been reconstructed or rehabilitated since 2009. The exception to this is Taxiway C, which was last rehabilitated in 1999 and is considered to be in "Fair" to "Poor" condition. Assuming the FAA 20-year life expectancy for pavement, this taxiway would be eligible for rehabilitation in 2019.

Routine maintenance, such as joint and crack sealing, should be performed on a scheduled basis to extend the pavement life. Taxiway C should be programmed for rehabilitation no sooner than 2019. Rehabilitation of other airfield pavements should be identified in appropriate timeframes within the 20-year planning period.

FIGURE 4-9 - EXISTING PAVEMENT CONDITION INDEX AND RANGE



Source: Colorado Department of Transportation Pavement Evaluations and Management 2017

4.2.5 Airfield Visual Aids

Airfield visual aids provide a variety of functions on an airport, including assisting aircraft in locating the airport, affording aircraft guidance to and alignment with a specific runway end, offering visual cues on surface weather conditions, providing direction for aircraft and vehicles operating on the ground, among other services. Generally, visual aids can be broken down into airfield markings, airfield signage, and airfield lighting.

Airfield Markings

According to FAA AC 150/5340-1L, *Standards for Airport Markings*, precision markings are required for runways with precision instrument approaches with vertical guidance lower than ¾-mile visibility minimums. As discussed in *Chapter Two*, FTG's Runway 17, Runway 35, and Runway 26 are currently all equipped with instrument landing systems (ILS) and appropriately marked for precision approaches. While Runway 8 currently only has a visual approach, it too has the more extensive precision approach markings that include the runway designator, centerline, threshold markings, aiming point, touchdown zone, and edge markings.

Taxiway Sign at FTG

All taxiways are marked with yellow centerline striping; and runway hold positions are appropriately marked with an enhanced yellow centerline to meet the new airport marking standards as required. However, the new TDG 2 taxiway pavement design standards in FAA AC 150/5300-13A should be evaluated against the existing taxiway connectors to ensure compliance prior to the next pavement maintenance projects for individual taxiways.

FTG's airfield markings are currently in compliance with FAA design standards; no action is required. During upcoming taxiway rehabilitation projects, it is recommended that the standards for TDG 2 be reviewed.

Airfield Signage

Airfield signage provides essential guidance information that is used to identify items and locations on an airport. FTG is currently equipped with standard FAA required signage including instruction, location, direction, destination, and information signs, and meet the standards given in FAA AC 150/5340-18F, *Standards for Airport Sign Systems.*

FTG's existing airfield signage meets FAA standards and is in excellent condition; no action is required.

Airfield Lighting

Airfield lighting provides enhanced situational awareness to those operating on or around an airport, particularly during times of reduced visibility (i.e., nighttime, inclement weather, etc.). For example, to land during periods of limited visibility, pilots must be able to see the runway or associated lighting at a certain distance from and height above the runway. If the runway environment cannot be identified at the minimum visibility point on the approach, FAA regulations do not authorize pilots to land.

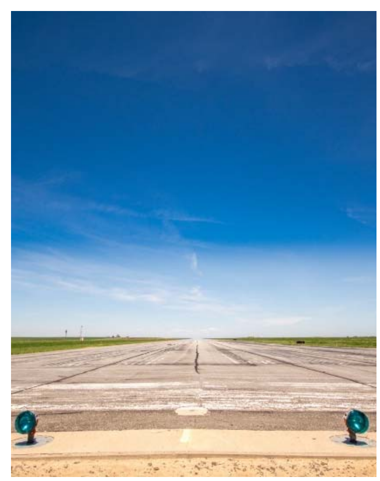

Runway Edge Lights at FTG

Table 4-11 shows the current airfield lighting available at FTG. In addition to this lighting equipment, the Airport is also equipped with a rotating beacon and two lighted windsocks. It is recommended that FTG continue to maintain its current light infrastructure. Additionally, it is recommended that the Airport pursue the installation of medium intensity taxiway lighting (MITLs) on Taxiway A, Taxiway, B, Taxiway C, and Taxiway E, as well as on their associated connector taxiways. Note that this would be consistent with FAA AC 150/5340-30D, *Design and Installation Details for Airport Visual Aids*, which recommends the installation of MITLs on taxiways and aprons at airports where runway lighting systems are installed.

TABLE 4-11 - AIRFIELD LIGHTING

Facility	Type of Approach	Edge Marking	Runway Approach Lighting	Visual Glide Slope Indicator (VGSI)	Lighting Owner
Runway 8	Visual	HIRL	REILs	PAPI	FTG (all)
Runway 26	Precision	HIRL	MALSR	PAPI	FTG (all)
Runway 17	Precision	MIRL	REILs	PAPI	FTG (all)
Runway 35	Precision	MIRL	MALSR	PAPI	FTG (all)
Taxiways A, B, C, E	-	None*	-	-	-
Taxiway D		MITL			

Source: Jviation; FAA 5010 Data; FAA Airport Facility Directory.
Notes:
HIRL: High Intensity Runway Lighting; MIRL: Medium Intensity Runway Lighting; REIL: Runway End Identifier Lights; MALSR: Medium Intensity Approach Lighting System w/ Runway Alignment Indicator Lights; PAPI: Precision Approach Path Indicator; MITL: Medium Intensity Taxiway Lighting
* Taxiways are equipped with blue and white reflectors

It is recommended that FTG install taxiway lighting systems on Taxiway A (including Taxiways A3-A9), Taxiway B, Taxiway C (including Taxiways C1-C2), and Taxiway E (including Taxiway E7).

4.2.6 Navigational Aids (NAVAIDs)

Glideslope Antenna at FTG

Navigational aids (NAVAIDs) consist of equipment to aid pilots in locating an airport (particularly for those airports without Air Traffic Control assistance during approach), provide horizontal guidance information for a non-precision approach, and provide horizontal and vertical guidance information for a precision instrument approach. Approach minimums for such procedures are based upon several factors, including aircraft characteristics, obstacles, navigation equipment, approach lighting, and weather reporting equipment. A summary of the existing visual and navigational aids and their conditions are shown in **Table 4-12.**

TABLE 4-12 - NAVAIDS AND VISUAL AID CONDITION

NAVAIDs and Visual Aids	Condition
Area Navigation (RNAV)/Global Positioning System (GPS) – Runways 17, 26, and 35	Good*
Instrument Landing System (ILS)/Distance Measuring Equipment (DME) and Localizer (LOC) – Runway 17, 26 and 35	Good*
Non-Directional Beacon (NDB) – Runway 26	Good*
High Intensity Runway Lights (HIRL) – Runway 8/26	Good
Medium Intensity Runway Lights (MIRL) – Runway 17/35	New
Runway End Identifier Lights (REIL) – Runway 8, Runway 17	New
Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) – Runway 26, Runway 35	Good
Precision Approach Path Indicators (PAPI) – Runway 8/26, Runway 17/35	New
Precision Runway Markings – Runway 8/26, Runway 17/35	Painted Bi-Annually
Medium Intensity Taxiway Lights (MITLs) - Taxiway B	Good
Airport Rotating Beacon	Good

NAVAIDs and Visual Aids	Condition
Runway & Taxiway Guidance Signs	Good
Automated Weather Observation System (AWOS)-3 & Automatic Terminal Information Service (ATIS) Frequency 119.025	Fair

*Owned, installed and maintained by the FAA

As discussed in **Chapter 2, Inventory**, FTG has seven published instrument approach procedures that are designed to provide pilots with varying degrees of navigational guidance at the Airport during inclement weather (i.e., when operating under instrument flight rules [IFR]). These procedures and their respective minimums are shown in **Table 4-13**. Note that of those seven, the Airport has three Category I ILS Precision Approaches installed on Runway 17, Runway 35, and Runway 26, all of which are owned and maintained by the FAA. Since Runway 8 has no instrument approaches, it is considered to be a visual runway. It should be acknowledged the lack of instrument approaches on Runway 8 is not because of any physical constraint or limitation, it is to minimize potential conflicts between aircraft landing on Runway 8 at FTG and aircraft operating on the north/south runways at Denver International Airport, located to the northwest of FTG.

TABLE 4-13 - INSTRUMENT PROCEDURE MINIMA

Instrument Approaches	Lowest Minimums (AGL and visibility)	Visual Aids
Runway 17 ILS	200 ft 3/4 sm	MIRL; REILs; PAPI
Runway 17 LPV (GPS)	200 ft 3/4 sm	MIRL; REILs; PAPI
Runway 26 ILS	200 ft 1/2 sm	HIRL; MALSR; PAPI
Runway 26 LPV (GPS)	200 ft 1/2 sm	HIRL; MALSR; PAPI
Runway 26 NDB MDA	555 ft 3/4 sm	HIRL; MALSR; PAPI
Runway 35 ILS	200 ft 1/2 sm	MIRL; MALSR; PAPI
Runway 35 LPV (GPS)	200 ft 1/2 sm	MIRL; MALSR; PAPI
Runway 8 Visual	3 miles	HIRL; REILs; PAPI

Source: Jviation, Airnav.com, FAA Instrument Approach Charts.
Notes:
HIRL: High Intensity Runway Lighting; MIRL: Medium Intensity Runway Lighting; REIL: Runway End Identifier Lights; MALSR: Medium Intensity Approach Lighting System w/ Runway Alignment Indicator Lights; PAPI: Precision Approach Path Indicator

FTG's existing NAVAIDs are adequate to meet the needs of the Airport throughout the planning period; no action is required.

4.2.7 Obstructions and Airspace Requirements

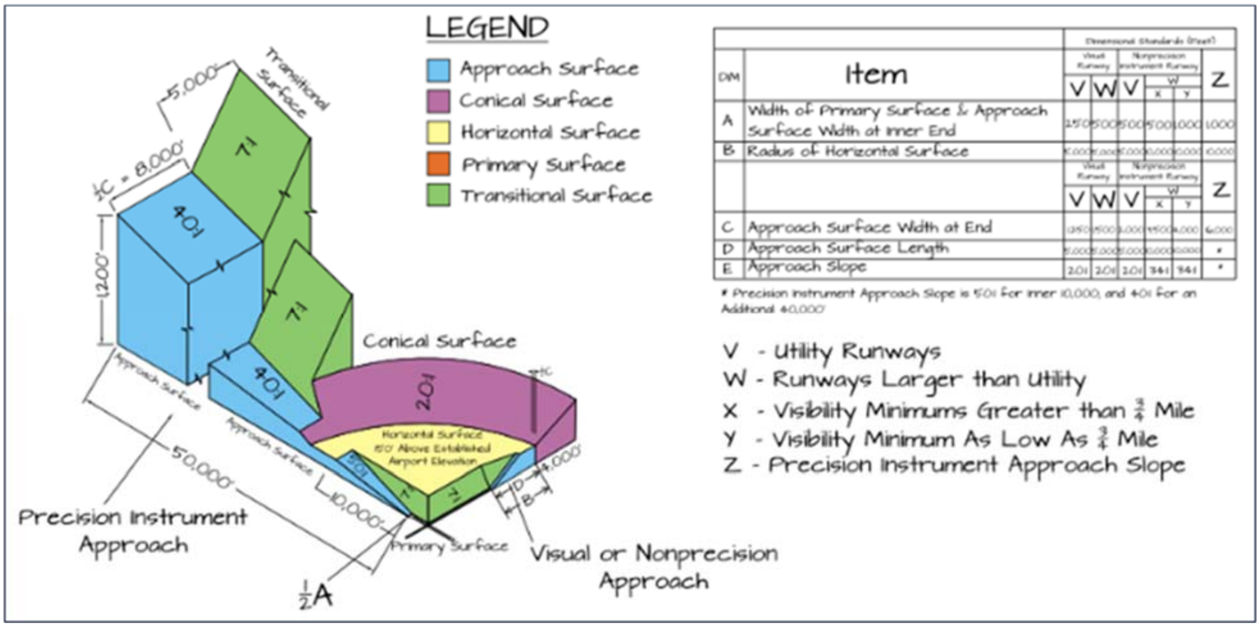
In addition to the primary airport infrastructure on the ground, the FAA also requires airports to consider airspace infrastructure that surrounds the airport. Specifically, through various federal regulatory resources such as Title 14, Code of Federal Regulations (CFR) Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*, FAA AC 150/5300-13A, *Airport Design*, and FAA Order 8260.3B, *U.S. Standard for Terminal Instrument procedures (TERPS)*, the FAA defines and establishes the standards for determining obstructions that affect airspace near an airport. These standards apply to the use of navigable airspace by aircraft and to existing or planned air navigation facilities (airports). This is enforced primarily through the definition of imaginary airspace surfaces that are sized based on the criteria they are designed to protect. Specifically, imaginary airspace surfaces are geometric shapes the size and dimensions of which are based on the category of each runway for existing and planned airport operations, the types of instrument approaches, and their enabling regulatory document. A penetration to these surfaces is considered to be an "obstruction," which can be an existing or proposed manmade object, object of natural growth, or terrain. Note that the FAA grant assurances signed by FTG require that the imaginary surfaces be cleared of all obstructions, to the extent feasible.

Any changes to the airfield must reviewed by the FAA to ensure the appropriate obstacle clearance necessary to maintain safe airport operations. Prior to any airport development, the Airport or the development sponsor must request the FAA to conduct an airspace evaluation to determine the potential impact that a project may have on airport safety, regardless of scale. Part of the airspace evaluation involves the determination of the impact of proposed development on an airport's imaginary airspace surfaces. For the purposes of the Master Plan, there are three primary regulatory documents (and their associated airspace surfaces) to be considered:

- 14 CFR Part 77 defines five imaginary surfaces as shown in **Figure 4-10**, including the Primary, Approach, Horizontal, Conical, and Transitional surfaces. Any object which penetrates these surfaces is considered to be an obstruction and may affect navigable airspace. Unless these obstructions undergo additional aeronautical study to conclude they are not a hazard, obstructions are presumed to be a hazard to air navigation.[1] Hazards to air navigation may include terrain, trees, permanent or temporary construction equipment, or permanent or temporary manmade structures (such as power lines) penetrating one of the 14 CFR Part 77 imaginary surfaces.
- FAA AC 150/5300-13A defines approach airspace surfaces that are separate from 14 CFR Part 77, and are designed to protect the use of the runway in both visual and instrument meteorological conditions near the airport. These approach surfaces are defined by each runway's current approach type (i.e., visual, non-precision instrument, etc.), and typically are trapezoidal in shape, extending away from the runway along the centerline and at a specific slope. To establish the location of a runway threshold, the associated approach surface must be clear of all obstructions. If it is not clear, either the obstructions must be removed, or the runway threshold must be relocated until its associated approach surface is clear.
- TERPS generally defines a wide variety of airspace surfaces that are designed to establish and maintain safe operational conditions around an airport for aircraft that are utilizing a defined instrument approach. Obstructions to a TERPS surface can result in operational impacts to the instrument approach that could include a raising of minimums, making the approach unavailable in certain conditions, or decommissioning the instrument approach altogether.

[1] Title 14, Code of Federal Regulations Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*

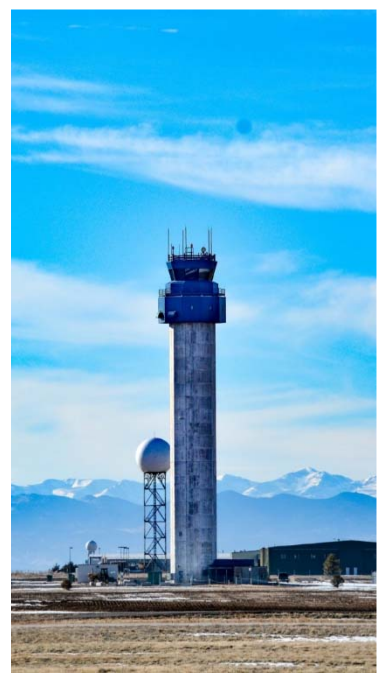
FIGURE 4-10 - 14 CFR PART 77 IMAGINARY SURFACES



Source: FAA 14 CFR Part 77*, Safe, Efficient Use, and Preservation of the Navigable Airspace*.

An obstruction survey will be completed as part of this Master Plan. Results of the obstruction survey will be submitted to the National Geodetic Survey (NGS) for review. Obstructions will be identified and included in the ALP set once finalized.

4.2.8 Airspace Class and Air Traffic Control



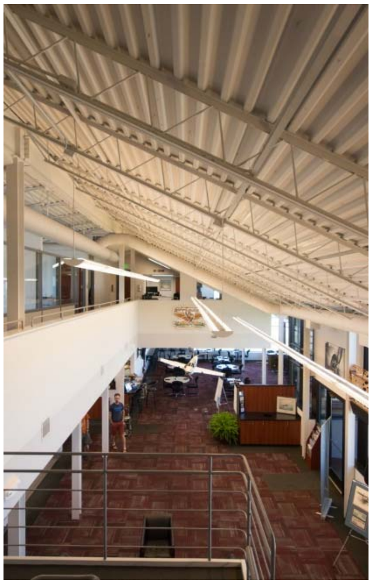
ATCT at FTG

The airspace that surrounds an airport is classified per the activity level of the facility and the presence of an air traffic control tower. FTG is currently in Class D airspace, which is airspace that surrounds an airport with an operating air traffic control tower. Because of its proximity to Denver International Airport (DEN), when Front Range Airport's ATCT is closed, it is subject to the requirements of DEN's Class B airspace.

FTG's current airspace classification is consistent with existing and future activity levels; no action is required.

4.3 Landside Facility Requirements

This section describes the landside facility requirements needed to accommodate FTG's general aviation activity throughout the planning period. Areas of particular focus include the terminal building, hangars, aprons and tie-down areas, automobile parking, access, as well as the various associated support facilities



Terminal Building at FTG (interior)

4.3.1 Terminal Building

The Front Range Airport Terminal Building is a 9,500-square-foot facility with two levels that accommodates a variety of functions for the Airport. Current activities in the terminal include airport administrative offices, a restaurant, and the Airport's only Fixed Base Operator (FBO), which itself includes operational areas, a customer service counter, conference rooms, a pilot lounge, a flight planning room, bathrooms, etc. In 2011, the terminal building underwent a major renovation and is in excellent condition. Based on discussions with airport management as well as an analysis utilizing standard terminal building programming criteria, the terminal building has been deemed to be adequate in size to meet existing and future demand throughout the planning period. The only recommendation is for the Airport to continue to maintain the facility appropriately.

FTG's current terminal building is adequate to meet existing and future activity levels; no action is required other than regular maintenance.

4.3.2 Aircraft Hangar Requirements

Hangar Buildings at FTG

Utilization of hangar space at airports varies as a function of local climate, security, and owner preferences. The trend in general aviation aircraft (single or multi-engine) is toward newer, more sophisticated and consequently, more expensive aircraft. Therefore, most aircraft owners reasonably prefer an enclosed hangar space to locating their aircraft outside on tie-downs. This is particularly true in states like Colorado, where harsh, cold-weather climates can degrade or damage aircraft stored outside. This trend has led to a general increase in demand for hangars and a reduction in demand for apron tie-down space.

Based aircraft are routinely stored at airports in a variety of hangar types. The type of hangars needed is usually determined by aircraft size, the type of aircraft owner (business or leisure), and the region of the country. Following are the types of hangars currently at or anticipated to be constructed at FTG:

- T-hangars: T-hangars are a series of interconnected (forming a single large structure) aircraft hangars with footprints in the shape of a "T" that can store one single- or multi-aircraft in each individual unit. At FTG, there are 12 T-hangar buildings (approximately 191,600 square feet) that have a total of 148 individual hangar units. According to Airport administration, there is currently a waiting list for T-hangars comprised of many aircraft owners currently based on an Airport and using tie-downs.
- Box Hangars: This hangar type generally includes individual, unattached, clear-span hangar units that are typically designed to accommodate one or two smaller aircraft. These can be attached as part of single building, or as standalone units. There are currently 21 structures of box hangars on the

Airport with 156 individual units for a total of approximately 439,300 square feet.

- Corporate Hangars: This classification typically includes larger, clear-span hangars used solely for storing aircraft and/or housing a variety of businesses that are located on the airport. These typically have an attached office and are used by one tenant only. These hangars can house just one or more corporate aircraft (i.e. turboprops and jets), depending on the owner's needs. FTG currently has nine such hangars ranging in size from 8,000 square feet to 34,000 square feet, for a total of approximately 160,000 square feet.

The demand for aircraft storage hangars is largely dependent upon the number and type of aircraft expected to be based at the airport in the future. For planning purposes, it is necessary to estimate hangar requirements based upon forecasted operational activity. Note that it is assumed that larger, higher value based aircraft are more likely to be stored in a hangar, as well as 100% of the based multi-engine aircraft fleet. Additionally, it is assumed that 100% of larger, higher value itinerant aircraft would prefer to be in a hangar. Based on those assumptions, the hangar space requirements by aircraft type can be found below in **Table 4-14**. (Refer to **Figure 2-11** and **Table 2-11** for hangar inventory and building layout.)

Hangar Buildings at FTG

Based on the analysis below, FTG's current hangar infrastructure requires a mixture of additional T-hangars and corporate itinerant hangars throughout the planning period. It is important to note, however, that hangar development is subject to the specific requirements of the users, meaning that even if an airport has capacity in its hangar inventory, it may not meet the particular needs of a given user. This is especially true for large box hangar and corporate tenants and it is for this reason that FTG should continue to preserve its hangar development concepts to maintain the potential for future customized development.

It is recommended that FTG plan for future T-hangar and corporate hangar development to accommodate immediate needs in addition to preserving potential hangar development modules for long-term development.

TABLE 4-14 - AIRCRAFT HANGAR REQUIREMENTS

	2017	2022	2027	2032	2037
Based Aircraft Demand					
– Single Engine	323	336	362	369	397
– Multi-Engine	36	36	38	41	44
– Jet/Turbine	5	12	13	23	25
– Helicopter	5	12	13	23	25
– Other (military / ultralight)	0	0	0	0	0
Total	369	396	426	456	491
T-Hangars / Small Box Hangars					
– Single Engine / Other (90%) (1,400 sf)	452,000	470,000	506,000	516,000	556,000
– Multi-Engine (90%) (1,600 sf)	75,000	75,000	81,000	87,000	93,000
– Jet / Turbine (0%)	0	0	0	0	0
– Helicopter (0%)	0	0	0	0	0
– Total T-Hangar Demand (aircraft)	235	243	262	269	289
– Total T-Hangar Demand (SF)	527,000	545,000	587,000	603,000	649,000
– Total Existing T-Hangar (SF)	324,864	324,864	324,864	324,864	324,864
Surplus/(Deficiency) (SF)	(202,136)	(220,136)	(262,136)	(278,136)	(324,136)
Large Box / Corporate Hangars					
– Single Engine / Other (5%) (1,400 sf)	194,000	202,000	218,000	222,000	238,000
– Multi-Engine (5%) (1,600 sf)	33,000	33,000	33,000	36,000	39,000
– Jet /Turbine (100%) (6,400 sf)	60,000	144,000	156,000	276,000	300,000
– Helicopter (100%) (2,000 sf)	10,000	24,000	26,000	46,000	50,000
– Total Demand (aircraft)	134	153	164	187	202
– Total Demand Aircraft (SF)	297,000	403,000	433,000	580,000	627,000
– Existing Hangars (SF)	465,974	465,974	465,974	465,974	465,974
Surplus/(Deficiency) (SF)	168,974	62,974	32,974	(114,026)	(161,026)
Itinerant Aircraft Demand					
– Total Demand (aircraft)	2	3	4	5	6
– Total Demand (SF)	24,000	36,000	48,000	60,000	72,000
– Existing Hangars (SF)	0	0	0	0	0
Surplus/(Deficiency) (SF)	(24,000)	(36,000)	(48,000)	(60,000)	(72,000)
Total Demand (SF)	848,000	984,000	1,068,000	1,243,000	1,348,000
Total Existing Hangars (SF)	790,838	790,838	790,838	790,838	790,838
SURPLUS/(DEFICIENCY) (SF)	(57,162)	(193,162)	(277,162)	(452,162)	(557,162)

Source: Jviation

4.3.3 Aircraft Parking Aprons

Terminal Apron at FTG

Aprons are considered premium airport space and should be strategically utilized to maximize their operational efficiency and benefit for the airport. Apron layout design should account for the location of airport terminal building, FBO facilities, and other aviation-related access facilities, as well as to provide parking for based and transient airplanes, access to the terminal facilities, fueling, and surface transportation. Apron spatial requirements for FTG were based on criteria provided in FAA AC 150/5300-13A, *Airport Design*. For planning purposes, apron area requirements focused exclusively on the Terminal Apron, where nearly all aircraft apron operations currently occur (note that the East Apron has an additional 505,000 square feet of pavement). Additionally, the apron area requirements were separated for based versus transient aircraft, and general aircraft size assumptions were made. The aircraft apron parking requirements for based and transient aircraft are presented in **Table 4-15**. (It should be noted that the apron area located west of the extended Taxiway A6 is considered to be the based aircraft apron, while the area east is designated as apron for transient aircraft operations.)

TABLE 4-15 - APRON PARKING REQUIREMENTS

	2017	2022	2027	2032	2037
Based Aircraft					
– Projected Apron Demand (SF)	50,056	52,647	55,310	61,000	63,773
– Current Apron Availability (SF)	382,500	382,500	382,500	382,500	382,500
Surplus/(Deficiency) (SF)	332,444	329,853	327,190	321,500	318,727
Transient Aircraft					
– Projected Apron Demand (SF)	113,960	117,782	126,195	147,662	156,348
– Current Apron Availability (SF)	391,250	391,250	391,250	391,250	391,250
Surplus/(Deficiency) (SF)	277,290	273,468	265,055	243,588	234,902

Source: Jviation

As shown in **Table 4-15**, FTG has a surplus of apron space for both based and transient aircraft. For based aircraft, this is consistent with the general industry trend to move aircraft off apron tie-downs and into hangars, protecting them from inclement weather. For transient aircraft, the results reflect an increasing amount of larger aircraft activity at FTG over the planning period. While that activity will not result in the need for additional apron space, it is recommended that the current transient apron layout and configuration (which was originally designed for based aircraft) be reassessed for transient aircraft use to maximize efficiency and convenience for transient users. Additionally, it should be noted that there are paved areas within the Airport's aprons and in particular those areas associated with the existing hangar development areas in need of maintenance and repair (**Routine maintenance*, such as joint and crack sealing, should be performed on a scheduled basis to extend the pavement life. Taxiway C should be programmed for rehabilitation no sooner than 2019. Rehabilitation of other airfield pavements should be identified in appropriate timeframes within the 20-year planning period.***

Figure 4-9).

FTG's current apron area is sufficient to meet for current and forecasted demand for based and transient aircraft. It is recommended that the transient apron layout be reassessed to ensure that it is configured in an appropriate manner for efficient transient use over the long term. It is also recommended that existing pavement conditions be assessed, repaired and maintained as required.

4.3.4 Landside Access and Parking Requirements

Regional Transportation Network

Regional roadway access to FTG provided by Interstate 70, E-470, East Colfax Avenue, Imboden Road, Manilla Road, and East 48th Avenue is adequate to accommodate the existing and projected need within the 20-year planning period.

FTG's existing regional roadway network is sufficient to meet the Airport's access needs throughout the planning period; no action is required.

On-Airport Circulation Roadways

Ground access to the terminal building is provided by Front Range Parkway, leading to the parking areas and hangar access, and provides curb front access and general circulation. Front Range Parkway is in good condition. There are multiple on-airport vehicle service roadways that provide access to the existing hangar facilities, as well as to the East Apron and ARFF/SRE areas on the east side of the airfield. They generally range in condition from good to fair, and appear to be adequate to meet Airport demand over the planning period.

FTG's existing on-airport roadways should be subject to regular maintenance to prolong their life expectancy; no other action is required.

Auto Parking

FTG currently has five paved auto parking lots, totaling approximately 280 public parking spots. The largest parking lot abuts the terminal building, which itself is capable of accommodating over 60 vehicles in paved, marked spots, in addition to a turf area estimated to be able to accommodate an additional 35 vehicles. For planning purposes, forecasted enplanements are utilized to determine auto parking space requirements for passengers, rental cars, and airport employee parking. (Note that restaurant parking requirements are a function of local business conditions and are not factored into this analysis.)

TABLE 4-16 - AUTO PARKING DEMAND

	2017	2022	2027	2032	2037
Forecasted GA Enplanements	24,831	26,120	28,432	30,983	34,141
Parking Spaces Requirement	61	66	72	78	86
Existing Terminal Area Parking	95	95	95	95	95
Surplus/(Deficiency)	34	29	23	17	9

Source: Jviation, FAA ATADS 2017

Based on this analysis, aviation-related auto parking at FTG is currently considered to be adequate for meeting existing and future demand levels.

FTG's existing on-auto parking areas are adequate to meet demand levels throughout the planning period. Other than regular maintenance, no additional action is required.

4.4 Airport Support Facilities

4.4.1 Airport Security

Airport security is essential to the safe operation of any airport. FTG should maintain a level of security that is commensurate with federal requirements and the industry's current best practices for a general aviation reliever airport. Regarding federal requirements, since FTG does not have an air carrier or a commercial operator with a security program, the Airport does not fall under 49 CFR 1544 or 1546, meaning that it is not under the direct regulatory authority of the Transportation Security Administration (TSA). However, the TSA has previously released guidance documents designed to establish non-regulatory best practices for general aviation airport security. This guidance from TSA, combined with direction from other aviation-related organizations (i.e., state aeronautics agencies, AOPA, NBAA, AAAE, ACRP, etc.), loosely comprise the general aviation industry's best management practices for security. (It should be noted that General Aviation Subgroup of the TSA Aviation Security Advisory Committee (ASAC) is currently in the process of providing updated recommendations to the TSA guidance.) In general, appropriate security measures should include the following:

- Controlling movement on the Airport: including the movement of persons, aircraft and ground vehicles on airport property by installing airport user signs, aircraft guidance signs, airfield lights and markers, and pavement markings, as appropriate.
- Preventing theft and illegal operation of aircraft: including airport lighting and promotion of aircraft owner anti-theft measures.
- Preventing unauthorized access: including unauthorized access of persons and ground vehicles into unauthorized areas on airport property. This entails, among other things, preventing unauthorized access into the Airport/Air Operations Area (AOA), moving between areas within the AOA, and separating / segregating persons and ground vehicles from aircraft, fueling facilities and other areas of concern within the AOA.

Additionally, the Transportation Security Administration's (TSA) Security Guidelines for General Aviation Airports publication states that an appropriate security boundary design is a function not only of its effectiveness in preventing unauthorized access, but also of the cost of equipment, installation, and maintenance. A scoring system developed by TSA and included in the document rates FTG in the "high" security category, which suggests security recommendations that include security fencing, closed circuit television (CCTV), intrusion detection system, access controls, lighting system, personnel ID systems, vehicle ID systems, challenge procedures, LEO support, the establishment of a security committee, transient plot sign-in/out procedures, signs, documented security procedures, all aircraft secured, positive passenger/cargo/baggage ID, community watch program, and a contact list.

Based on these considerations, the following recommendations are made for FTG to deter unauthorized access to restricted airport areas and improve safety.

- Perimeter security fencing and access control: FTG does not currently have any perimeter security fencing. Fencing is an important airport attribute designed to increase not only airport security, but also airport safety in that it aids in the prevention of wildlife intrusions. The 2011 Colorado Aviation System Plan recognized FTG for its lack of security fencing, considering the Airport to be a "medium" risk. Additionally, the plan recommended an access control system, as well as a personnel and vehicle identification system. (Note that a service/perimeter road should be constructed in association with a new security fence to help maintain/inspect the fence and enhance security.
- Enhanced surveillance: Selected areas of the Airport should be monitored by video or camera surveillance. Cameras or systems with improved capabilities are recommended in sensitive areas and can be connected to airport administration/operations as well as local law enforcement.
- Area lighting: Improved lighting in the terminal area such as terminal vehicle parking lot and transient aircraft parking apron area to enhance safety and security should be considered.
- Security Checks: Regular airport staff patrols along the Airport perimeter are recommended to conduct maintenance operations and security inspections.

It is recommended that FTG consider airport security enhancements that include the installation of fencing and access controls, as well as that potential installation enhanced surveillance equipment, area lighting, etc.

4.4.2 Fuel Storage Requirements

As a major revenue source for the maintenance and operation of the Airport, aviation fuel sales have significant financial impact for the Airport in addition to benefiting its users. FTG has one 10,000-gallon Avgas aboveground storage tank (AST) located west of the terminal building, and three underground fuel storage tanks (UST) located at the fuel farm: one 20,000-gallon Avgas fuel tank, and two 15,000-gallon Jet-A storage tanks. There is also a 1,000-gallon Mogas AST located at the fuel farm. Additionally, the Airport has mobile fueling trucks including a 1,000-gallon Avgas truck, a 500-gallon Avgas truck, and a 2,000-gallon Jet-A truck. All storage tanks and fuel trucks are owned Adams County and operated by airport personnel through the Airport FBO.

Self-Serve Avgas at FTG

As with similar airports, fuel storage requirements are typically based upon maintaining a two- or three-week supply of fuel during an average month. The availability for more frequent deliveries can reduce the fuel storage capacity requirement. Storage beyond a four-week period is not recommended as it could degrade the quality of fuel. Because an increasing percentage of future aircraft utilizing the Airport will require Jet-A fuel, future fuel storage requirements may consider increasing Jet-A fuel requirements.

As shown in **Table 4-17**, FTG's existing fuel storage provides an adequate level of service for existing and future operations for the 20-year planning period. Existing storage capacity also is adequate to account for any potential limited disruption in fuel delivery services. It should also be noted that underground storage tanks are generally being replaced by aboveground tanks for a variety of reasons including cost, environmental considerations, risk management, etc. As it continues to monitor the condition of its fuel tanks, FTG should consider aboveground tanks as a potential ultimate condition.

TABLE 4-17 - FUEL TANK STORAGE REQUIREMENTS

	2017	2022	2027	2032	2037
Average day peak month departures	167	175	193	212	233
Avgas					
– Storage Requirement (gal)	17,215	17,652	19,031	20,436	22,548
– Existing Storage Capacity (gal)	30,000	30,000	30,000	30,000	30,000
Surplus/(Deficiency)	12,785	12,348	10,969	9,564	7,452
Jet-A					
– Storage Requirement (gal)	18,321	20,274	23,273	26,843	29,430
– Existing Storage Capacity (gal)	30,000	30,000	30,000	30,000	30,000
Surplus/(Deficiency)	11,679	9,726	6,727	3,157	570

Source: Jviation.

FTG's fuel tanks provide adequate capacity to accommodate both existing and projected demand. It is recommended that the Airport appropriately maintain its existing fuel tanks and prepare for a potential expansion of its Jet-A capacity over the long term.

4.4.3 Deicing Facilities

All FTG deicing fluids are stored securely in the FBO hangar, and according to Airport Administration, the FBO uses less than 20 gallons of deicing fluid annually. At this level, the Airport is not required to control the deicing fluid discharge through a glycol recovery and containment system. However, FTG should continue to monitor its deicing activities to ensure compliance with US EPA standards. Based on the demand forecast over the 20-year planning period, glycol containment or collection is not required for FTG.

FTG's current deicing operations comply with US EPA requirements; no action is required.

4.4.4 Aircraft Rescue and Firefighting (ARFF) Station/Snow Removal Equipment (SRE)/Maintenance Facilities

FTG has two buildings located on the East Ramp that accommodate the Airport's ARFF and SRE operational needs. The larger of the two buildings was constructed in 1993 and is approximately 11,000 square feet. This facility contains storage for ARFF and SRE vehicles and associated equipment, as well as offices, general storage, a kitchen, and a training area. Located immediately to the east, the second building is approximately 6,400 square feet and was constructed in 2012. It also houses SRE and maintenance equipment.

SRE Storage Facilities at FTG

Airport Administration has reported that the combined space of the two buildings is insufficient to keep all its equipment under cover. FAA AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*, requires that SRE storage space be allocated to accommodate storage areas, support areas, and special equipment areas. To minimize the deterioration of that equipment that must still be stored outside, the Airport wants to consider the construction of an additional storage structure to protect the equipment from the elements. Airport staff has indicated, an additional storage space of 80-feet by 80-feet (6,400 square feet) would be adequate to accommodate the Airport's long-term SRE storage needs.

It is also important to note that the existing buildings are not optimally located to provide the most immediate and efficient response to relevant events. Ideally, emergency vehicles stored in the buildings would have immediate taxiway (if not runway) access and would not have to cross a runway unless it they were operating on it. In terms of very long-term planning, the Airport should consider an ultimate location to accommodate these operations that maximize their efficiency and safety. Any recommendations associated with this should be reflected on the Ultimate Airport Layout Plan.

It is recommended that an additional 6,400 square feet of storage be constructed to accommodate existing and future SRE vehicles and equipment within the 20-year planning period. Additionally, the Airport should consider an ultimate location for its ARFF and SRE operational areas.

4.4.5 Airport Equipment

Aircraft Rescue and Firefighting Equipment

Snow Blower at FTG

FTG's existing ARFF vehicles meet ARFF Index B[2] requirements and are considered to be in fair to good condition. These vehicles are stored under cover in a maintenance bay with most of the SRE and other maintenance vehicles. Additionally, FTG ARFF requirements are supported by a mutual governmental agreement with the Bennet Fire Department (BFD) which has donated previously used firefighting equipment to the Airport.

No additional or replacement ARFF equipment is recommended for this planning period.

Snow Removal Equipment and Maintenance Equipment

FTG’s current SRE and airfield maintenance equipment (listed previously in *Chapter Two*) is currently adequate to meet the requirements of FAA AC 150/5200-30C, *Airport Winter Safety and Operations*. However, it should be noted that FAA Order

[2] Although not certificated under 14 CFR Part 139, *Certification of Airports*, FTG voluntarily provides ARFF equipment and extinguishing agent equivalent to Part 139 Index B requirements (see Part 139.317, *Aircraft rescue and firefighting: Equipment and agents*).

5100.38D, *Airport Improvement Program Handbook (AIP)*, specifies that the useful life for equipment to be 10 years. In considering the eligibility for replacing equipment, it must be designed and justified based on both FAA AC 150/5200-30, and AC 150/5220-20, *Airport Snow and Ice Control Equipment*.[3] Maintenance vehicles for safety area mowing and wildlife management consist of the 2014 John Deere 5085E tractor (condition new), the 2009 New Holland TV 6070 tractor (condition good), the 1992 Bush Hog mower deck (condition poor), the 1991 Rhino mower deck (poor), and the 2009 Schulte mower deck (poor). It is recommended that the airport maintenance vehicles be replaced during the 20-year planning period.

The two 1993 Oshkosh P-Series trucks, two 1996 Stewart Stevenson Brooms, and 2001 Case 821 C Loader are recommended to be replaced within the 20-year planning period and are currently in the Airport's Capital Improvement Program. The vehicles that will need to be replaced, based on the replacement schedule include the; 1993 and 1994 International Paystar brooms, the 1993 International plow trucks, the 1983 and 1987 Oshkosh blowers and the 2003 Oshkosh broom during the 20-year planning period.

Ground Support Equipment (GSE)

Ground support equipment at FTG is provided by Premier Aviation FBO, which is owned by Adams County. GSE can include aircraft tugs, deicers, ground power units, lavatory carts, potable water carts, baggage carts, belt loaders, air stairs, and other service vehicles. The Airport's existing GSE is stored in a storage bay on the east side of the terminal building. Note that the amount of GSE required at an airport is generally determined by the demand of individual operators. GSE at the Airport is projected to be adequate to meet the demand of existing and future operations. Existing parking for GSE is also adequate for existing operations. FTG will need to continue to maintain or replace its equipment as required.

GSE equipment storage is adequate for current and future demand during the 20-year planning period.

4.4.6 Utilities

All utility lines serving the Airport are buried underground and provide service to the terminal building, hangar area, airfield facilities, lighting, and navigation aids. Utilities at FTG include water, sanitary sewer, phone, electric, storm water, and natural gas. Wastewater is treated on-site via a wastewater treatment facility that was built in 2008 and located west of the airfield. The current utilities at the Airport are adequate for the existing structure as well as for potential taxiway lighting system installment. For future hangar and/or landside development, the water lines and wells would need to be analyzed for capacity and/or limitations to the current system.

It is recommended that FTG maintain the utility infrastructure to meet current demand within the 20-year planning period. As future landside and hangar

[3] For airports that are not 14 CFR part 139 certificated airports, per FAA policy, only one snow removal carrier vehicle is eligible unless the ADO concurs that the airport is large enough, busy enough, and/or has significant snowfall to warrant an additional vehicle.

development occurs, utility locations and capacity would have to be analyzed for limitations to the current infrastructure.

4.5 Other Airport Considerations

4.5.1 Airports Geographic Information Systems (AGIS)

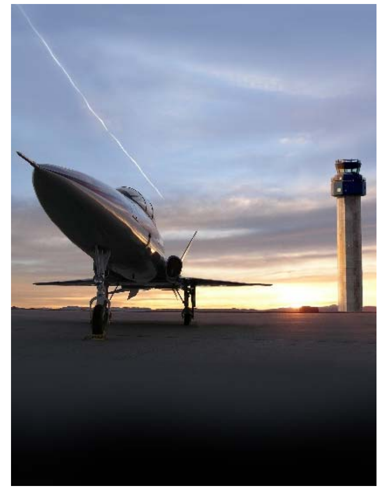
To better support FAA NextGen, GIS standards have been introduced and are gradually being phased in over time. The goal with NextGen is to create a system-wide standard for collection and input of aviation data. The FAA introduced three new advisory circulars to provide guidance for these new standards, which became mandatory for all federally obligated airports on September 2009. FAA AC 150/5300-16A, *General Guidance and Specifications for Aeronautical Surveys*, FAA AC 150/5300-17C, *General Guidance and Specifications for Aeronautical Surveys: Airport Imagery Acquisition and Submission to the appropriate government agencies*, and AC 150/5300-18B, *General Guidance and Specification for Aeronautical Surveys: Airport Survey Data Collection and Geographic Information System Standards,* describe how the data is collected and processed. As part of the Master Plan, GIS data will be collected in accordance with these criteria and aeronautical information included on the ALP.

FTG will be compliant with the AGIS requirement at the completion of this Master Plan.

4.5.2 Spaceport Colorado

Front Range Airport has recently submitted an application to the FAA's Office of Commercial Space Transportation for a Commercial Launch Site Operator License to conduct spaceport launch activities based on a horizontal takeoff, horizontal landing, manned, reusable launch vehicle (RLV) based at FTG. The Office of Commercial Space Transportation is charged with ensuring the protection of the public, property, and the national security and foreign policy interests of the United States during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation. Federal law requires commercial launch operators to hold licenses, either as permission for a single launch of a specific vehicle or a broader license to allow a certain type of vehicle to be launched by that operator from a specific facility. These licensing certificates are active for five years from date of approval.

The operational and development requirements of a spaceport are directly related to the specific launch vehicles that utilize the facility. Each RLV and operator has specific requirements that must be satisfied before a spaceport can support their needs. Facility requirements, dictated by launch vehicle type, include the specific requirements of propellant storage and loading, the housing of the RLV prior to and after flight, as well as processing, maintenance, and integration of vehicle components. Airfield facilities, such as runways and taxiways, also must meet the specific needs of each RLV. In addition, planned facilities should include a terminal that will serve as a departure/arrival point for spaceflight participants and guests, mission control, a training/education center, and media access. However, it must also be recognized that any commercial space facilities would have to be incorporated into existing airfield facility infrastructure in accordance with current FAA safety requirements and Federal grant assurances.



The existing airfield infrastructure at FTG, including existing runways and taxiways, is fully capable of supporting operations by any RLV operator currently being considered in the existing application. The primary focus of facility requirements associated with spaceport development is the need to isolate a space vehicle that is fully loaded with fuel and oxidizer, due to the potential for explosion. These setback requirements must be observed while keeping spaceport operations compatible with all other existing and planned activities and development at the Airport.

Through previous spaceport planning efforts that include the *2014 Spaceport Colorado* Business Plan and the 2015 Environmental Assessment (EA) for Front Range Airport Launch Site Operator License, facility requirements for the current spaceport proposal have been identified that include two mission prep areas, a fuel storage area, an oxidizer storage area, and a static hot fire test stand area. These are pursuant to the provisions set forth in 14 CRF 400-460 that regulate requirements such as launch safety, launch and reentry of an RLV, experimental permits, financial responsibility and human space flight requirements.

The commercial space launch business is rapidly changing and developing—in fact, it should be considered an industry in its infancy; therefore, particularly when it comes to horizontal-launch vehicles, infrastructure improvements at FTG must be carefully planned and justified to ensure they are both necessary and affordable. To that end, any potential infrastructure improvements will need to meet the criteria of being suitable for aviation use should commercial space operations prove not viable.

For the purposes of the FTG Airport Master Plan, only the airport land area needed to meet the potential facility requirements for Spaceport Colorado will be considered. The following chapter will only reserve appropriate areas for the potential development of these facilities.

4.6 Airport User Survey

FTG users were surveyed in 2015 about the condition of airport facilities, operations, safety and services (see **Figure 4-11** and **Figure 4-12**). In general, the Airport received primarily positive responses (average to excellent) and other comments generally supported the recommendations included in this chapter.

FIGURE 4-11 - FTG USER SURVEY RESPONSES

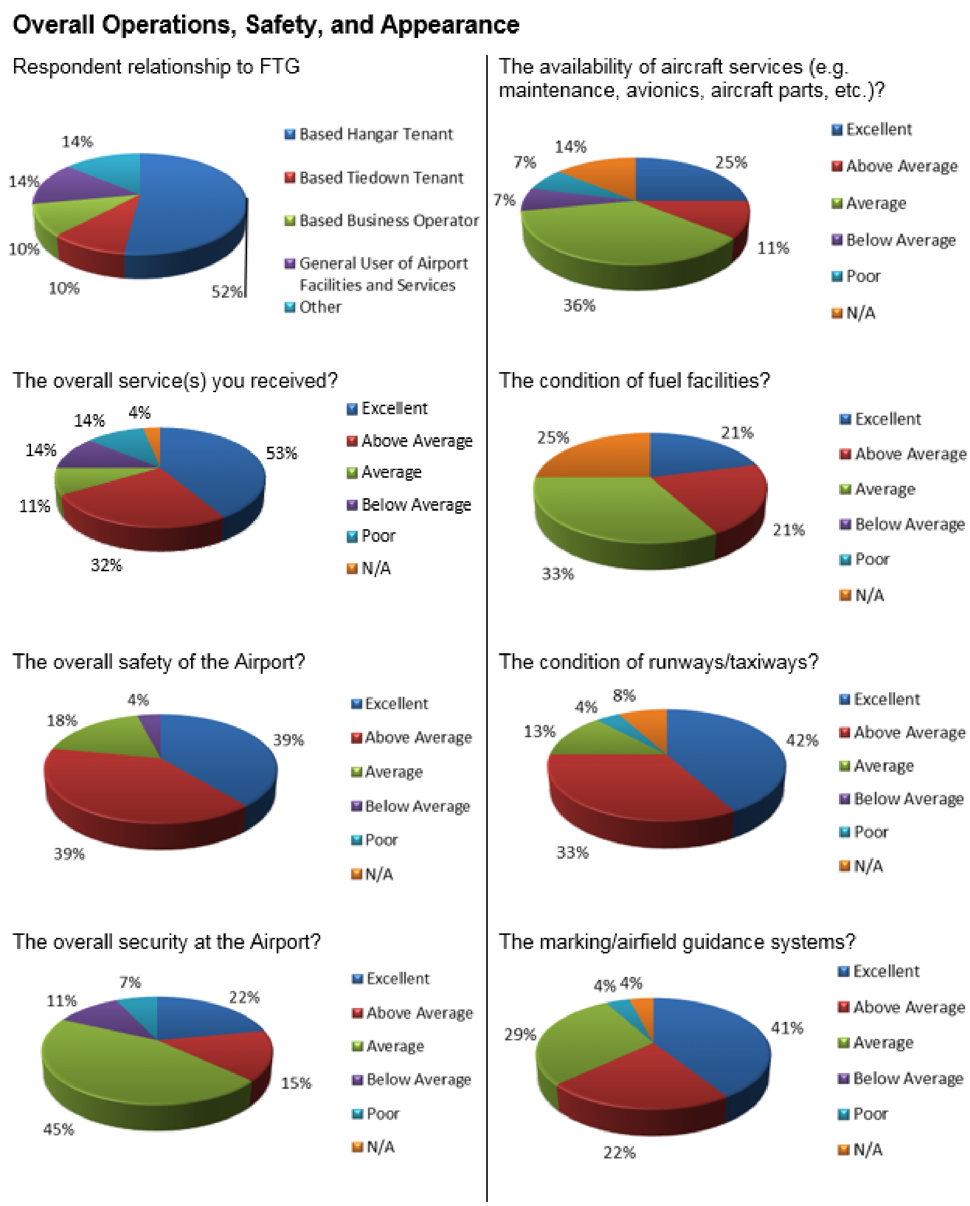
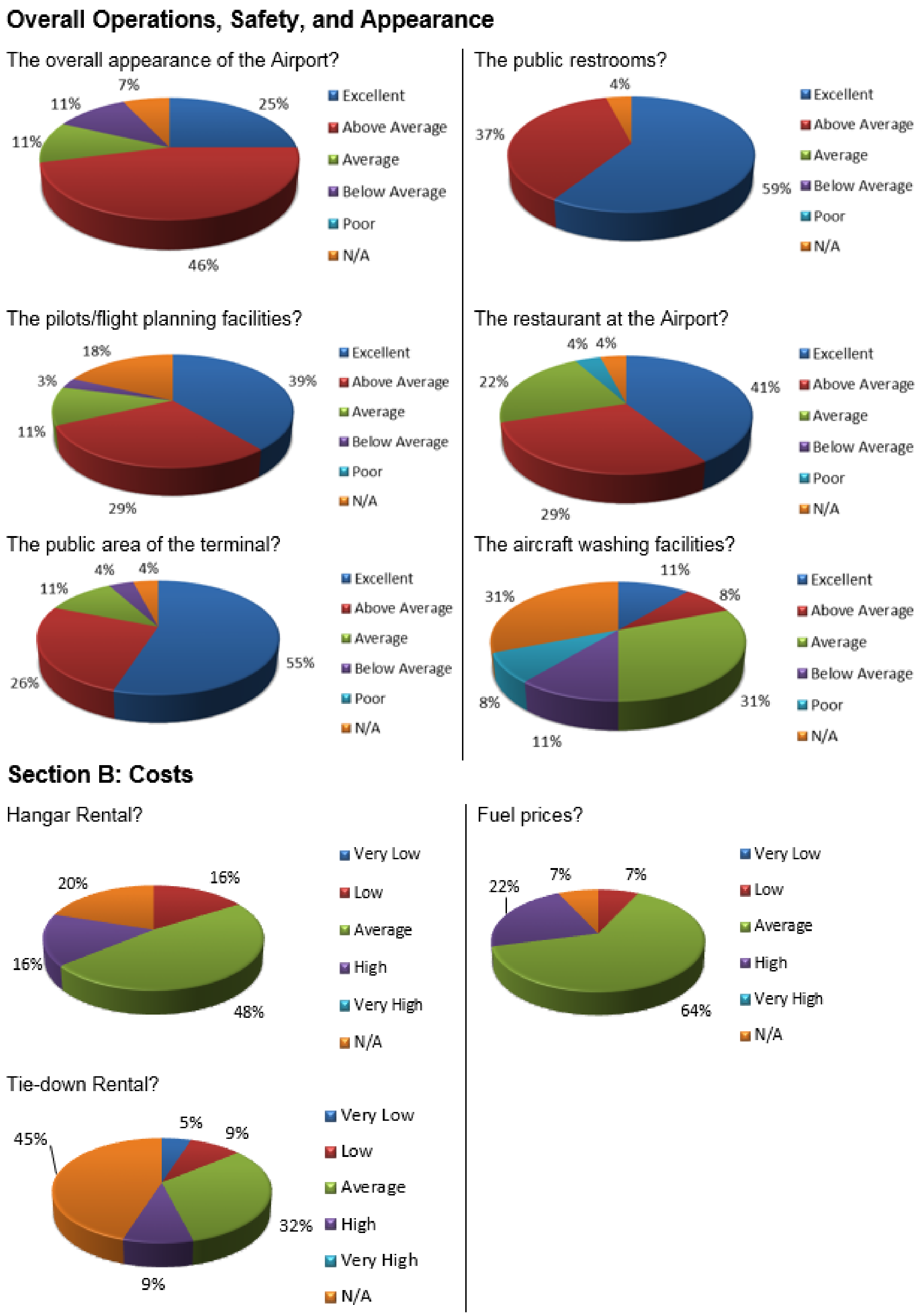


FIGURE 4-12 - FTG USER SURVEY RESPONSES



4.7 Previous Master Plan Deficiencies & Recommendations

In addition to meeting long-term operational demands and complying with FAA design standards, the 2005 Front Range Airport Master Plan Update had two primary focal points:

- Promote and Enhance General Aviation Activities: identify requirements to meet the long-term operational demands of the general aviation community and to fully accommodate general aviation design aircraft and allow for appropriate growth and development.
- Provide Opportunity and Environment for Air Cargo Operations: identify requirements within developed air cargo forecast scenarios to establish viable air cargo facilities, as well as the airfield infrastructure required for them to operate.

Specific facility requirements were generated for each of these focal points and they are summarized **Table 4-18**. Note that the 2005 Master Plan assumes that the general aviation requirements would be needed since that was the primary role of FTG. Additionally, based on the assumption that air cargo operations could be established at the Airport, an additional layer of facility requirements were identified to meet the needs of that potential activity.

Since the completion of the 2005 Master Plan, air cargo operations have not materialized as had been speculated. However, the facility requirements identified for general aviation activities remain valid and are in fact consistent with many of the facility requirements listed previously in this chapter.

TABLE 4-18 - 2005 FTG MASTER PLAN UPDATE FACILITY REQUIREMENTS

	Existing Conditions	Proposed Development General Aviation	Proposed Development Air Cargo
Access	Imboden Road to 48th Ave	Improve Imboden Road to 48th Ave	Improve and extend Manilla Road
Auto Parking	1,666 Parking Spaces	125 Parking Spaces	22 Parking Spaces
Air Traffic Control Tower	None	190-foot ATCT	190-foot ATCT
Critical Aircraft Design Group	Challenger CL 604 C-II	Gulfstream IV D-II	Airbus A300F C-IV
Runway 8/26 – Length – Width – Strength	 8,000' 100' 40,000 lbs. DWG	 8,000' 100' 90,000 lbs. DWG	 10,000' 150' 380,000 lbs. DTWG
Runway 17/35 – Length – Width – Strength	 8,000' 100' 37,000 lbs. DWG	 10,000' 100' 90,000 lbs. DWG	 12,000' 150' 380,000 lbs. DTWG
Taxiway A – Width – Separation – Strength	 50' 400' 40,000 lbs. DWG	 50' 400' 90,000 lbs. DWG	 75' High Speed 600' 380,000 lbs. DTWG
Taxiway B & C – Width – Separation – Strength	 50' N/A 40,000 lbs. DWG	 50' N/A 90,000 lbs. DWG	 75' N/A 380,000 lbs. DTWG
Taxiway D – Width – Separation – Strength	 50' 500' 40,000 lbs. DWG	 50' 500' 90,000 lbs. DWG	 75' High Speed 500' 380,000 lbs. DTWG
Taxiway E – Width – Separation – Strength	 N/A N/A N/A	 50' High Speed 600' 90,000 lbs. DWG	 75' High Speed 600' 380,000 lbs. DWG
Navigational Aids	CAT I ILS (8/26) CAT I ILS (17/35)	None None	CAT III ILS (8/26) CAT III ILS (17/35)
Lighting & Marking – Taxiway System – Runway Centerline – Touchdown Zone – Runway Visual Range	 Reflectors None None None	 MITLS Not Required Not Required Not Required	 MITLS Required Required Required
Air Cargo Facility	None	Not Required	21,500 SF Building
De-Icing Apron	100' x 50' Concrete Pad	100' x 50' Concrete Pad	150' x 200' Deicing Apron
– ARFF Index – ARFF Vehicle	Index "A" 1 Vehicle	Index "B" 2 Vehicles	Index "D" 3 Vehicles
Snow Removal Equipment	See Inventory	1 - High Speed Snow Plow	2 - High Speed Snow Plow
Fuel Storage	(2) 15,000-gal Jet A (1) 20,000-gal Avgas	(4) 15,000-gal Jet A (1) 20,000-gal Avgas	(6) 30,000-gal Jet A (1) 20,000-gal Avgas

Source: 2005 Front Range Airport Master Plan Update.

4.8 Regional Airport System Role

In 2011, CDOT Aeronautics Division published the Colorado Aviation System Plan. The Plan evaluated and measured the performance of the Colorado system of publicly-owned airports and assigned each airport to one of three functional categories:

Major, Intermediate, or Minor. The Plan currently has FTG classified as a Major General Aviation Reliever airport and is included in the National Plan of Integrated Airport System (NPIAS). CDOT evaluated the Airport's current facilities against the Plan's objectives and identified facilities and services that required improvement. **Table 4-19** provides a summary of that evaluation.

TABLE 4-19 - CDOT 2011 IDENTIFIED BENCHMARKS FOR FTG

CDOT Benchmark	CDOT Standard	FTG Existing Condition	Meets Standard?
Federal Aviation Regulations (FAR) Part 77 Compliance	– FAR Part 77 Airspace Drawings – Part 77 local height Zoning	– FAR Part 77 Drawings – Part 77 Zoning	Yes
Master Plan update every five years for Major Category Airports	Master Plan completion for: FTG YR 2013	Last Master Plan: 2004	No*
King Air B200 Airport Accessibility (emergency aircraft operating on minimum runway) (single pilot, up to 7 passengers)	RW length requirement, weather reporting, rotating beacon, published approach, MIRL or HIRL	Has all facilities	Yes
Learjet 35 Airport Accessibility (emergency aircraft) (2 crew, up to 9 passengers)	RW length requirement, weather reporting, rotating beacon, published approach, MIRL or HIRL	Has all facilities	Yes
Existing runway length	Major General Aviation Reliever Airport accounting for 75% of large aircraft at 90% useful load	8,000 feet	No
Primary Runway Pavement Condition Index (PCI) rating	Primary Runway PCI of 75 or greater	PCI of 90	Yes
Primary Taxiway Pavement Condition Index (PCI) rating	Primary Taxiway PCI of 75 or greater	PCI of 58	No*
Primary Apron Area PCI Rating	Primary Apron PCI of 75 or greater	PCI of 86	Yes
Security Level Classification based on TSA Guidelines by System Plan Role	Minimum, Low, Medium, High Risk	Medium Risk	No/NA
Recent and Pending LPV/APV Approaches for System Airports	If a Major category airport cannot accommodate an ILS, the airport should at least have an approach with vertical guidance	Published since 2005	Yes
GPS Approach Status for Major and Intermediate Airports	Included in 2005	Publish Date: 9/25/2005	Yes
Major Airport Performance Snow Removal Equipment Objective	Snow Removal Equipment Plan by year 2011		Yes
Major Airport Facility and Service Objectives De-Icing Equipment	De-Icing Equipment Objective in YR 2011		No
Airport Safety/Security Fencing	NPIAS Airport Security/Safety Fence		No
Facility and Service Objectives:			
– Runway Width	RW Width Objective 75 feet in YR 2000, 2005, 2011	RW width of 100 feet	Yes
– Runway Strength	Runway Strength Objective of 34,000 pounds in YR 2000, 2005, 2011	30,000 pounds	Yes
– Taxiway Type	Major Airports: Full or partial parallel Taxiway	Full Parallel Taxiway	Yes
– Published Approach	Published Approach Objective: Precision in YR 2000, 2005, 2011		Yes
– Visual Aids	Rotating beacon, lighted wind cone, REILs, PAPIs, VASIs in YR 2000, 2005, 2011		Yes
– Runway Lighting	Runway Lighting HIRL or MIRL in YR 2000, 2005, 2011	HIRL	Yes
– Weather Reporting Facilities	On-site ASOS or AWOS	AWOS	Yes

CDOT Benchmark	CDOT Standard	FTG Existing Condition	Meets Standard?
– Telephone, Restroom, FBO, Aircraft Maintenance, Fuel: Jet A & 100LL, Courtesy Car, Taxi/Shuttle, Rental Car, Terminal, Apron, Hangars, Auto Parking	Met Objectives in YR 2000, 2005, 2011		Yes

*Has since been corrected since 2011

It was determined that FTG does not meet some airport-specific objectives identified in the 2011 System Plan[4] (several of the deficiencies either have been or are in the process of being addressed). Of greatest significance is the recognition that FTG does not have safety/security fencing, an important improvement to increase airport safety and security in that it helps protect airport assets, and aids in prevention of wildlife intrusions[5]. The Plan also recommends the integration of an access control system and suggests that FTG convene a security committee to address long-term security enhancements. Finally, it should be recognized that the Plan recommends a runway length benchmark of 8,950 feet, 950 longer than the Airport's existing runways. The study also acknowledges that "aircraft can operate on runway lengths that are less than optimum if they shorten their trips lengths and/or depart with less than full loads."

4.9 Summary

A summary of the facility improvements that currently need to be addressed during the 20-year planning period is provided below in **Table 4-20**. Certain improvements will be further examined in **Chapter Five - Alternatives Analysis** to evaluate options to accommodate the facility requirements.

TABLE 4-20 - FACILITY REQUIREMENTS SUMMARY

Facility	Identified Requirement
Airfield Facility Requirements	
Airfield Demand Capacity	– No action required
Airport Design Standards	– No action required
Runways	– Preserve potential runway extensions and widening in Ultimate ALP – Add blast pads to Ultimate ALP per FAA AC 150/5300-13A
Taxiways	– Update fillet standards per FAA AC 150/5300-13A – Eliminate direct access from apron to runway via Taxiways A5, A6 and D7 per FAA AC 150/5300-13A – Resolve potential operational conflicts on Taxiway E – Preserve potential taxiway system expansion in Ultimate ALP
Airfield Pavement	– Investigate existing pavement strength of Runway 17/35 – Investigate potential selected strengthening of taxiways to support Runway 17/35
Airfield Visual Aids	– Install MITLs on Taxiway A, Taxiways A3-A9, Taxiway B, Taxiway C, Taxiways C1-C2, and Taxiway E and E7

[4] 2011 Colorado Aviation System Plan Technical Report, Colorado Department of Transportation, Division of Aeronautics. http://www.coloradodot.info/programs/aeronautics/colorado-airport-system/2011SP_TechReport/view

[5] 2011 Colorado Aviation System Plan Technical Report, CDOT; 'the system plan has not established a specific objective related to which system airports should have fencing, not has an objective been established as to how much fencing is appropriate, since conditions at each airport vary."

Facility	Identified Requirement
Navigation Aids (NAVAIDs)	– No action required
Obstruction Removal	– Recommendations to be incorporated into the ALP set
Landside Facility Requirements	
Terminal Building	– No action required
Aircraft Hangar Requirements	– Prepare for short-term T-hangar development – Preserve / refine hangar development modules
Aircraft Parking Aprons	– Redesign transient apron
Landside Access and Parking Requirements	– No action required
Airport Support Facility Requirements	
Airport Security	– Construct security fence and perimeter road – Install access control – Establish Airport Security Committee
Fuel Storage Requirements	– No action required
Deicing Facilities	– No action required
ARFF / SRE Facilities	– Construct an SRE/maintenance building of 6,400 square feet
Airport Equipment	– Replace SRE and maintenance vehicles as they reach their useful life, as reflected on CIP.
Utilities	– No action required
Spaceport Facilities Requirements	
Spatial Requirements	– Reserve appropriate airport land area required to meet projected facility needs for potential spaceport operations – Ensure that prospective spaceport development areas do not adversely impact traditional airport operational activities.